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Evaluation of Leafy Green Species Popular Among Ethnic Groups for Production and Markets in the Northeastern USA

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EVALUATION OF LEAFY GREEN SPECIES POPULAR AMONG ETHNIC GROUPS FOR PRODUCTION AND MARKETS IN THE NORTHEASTERN USA

A Dissertation Presented

by

RICARDO ANTONIO ORELLANA

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DEDICATION

To my children, wife, grandmother, parents, brothers and sisters, nephews and niece.

ACKNOWLEDGMENTS

I want to express my gratitude to my advisor, Dr. Frank Mangan, for his four years of thoughtful, patient guidance, and support. Special thanks are also to Dr. Mangan's Graduate and Undergraduate students their enthusiasm and ability to work as a team, and selfless contribution to my professional development have been invaluable and will forever be appreciated. I would like to extend my gratitude to the members of my committee, Dr. Wesley R. Autio and Dr. Richard T. Rogers for their well-founded input, precious comments and suggestions on all stages of this project. I want to thank the United States Department of Agriculture, Rutgers University, the University of Florida and the University of Massachusetts Amherst for funding this research and allow me being part of this joint undertaken project. I also want to express my gratitude to the Trustees of Lotta Crabtree Agricultural Fund for awarding me with a fellowship on two occasions. Thank you to Maria Moreira and her organization World Farmers for its contribution at the beginning of this project. Also, I want to express thanks to the Stockbridge School of Agriculture at UMass Amherst for allowing me to be part of its team of teaching assistants. Acknowledgments to farmers, and people of farmers markets and supermarkets that contributed to the development of this project. Finally, a special thank you to my wife Mildred, my son Ricardo and my daughter Mildred whose support and love helped me to stay focused on this project.

ABSTRACT

EVALUATION OF LEAFY GREEN SPECIES POPULAR AMONG ETHNIC GROUPS FOR PRODUCTION AND MARKETS IN THE NORTHEASTERN USA

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This dissertation addresses the need to evaluate the potential of leafy green species popular among ethnic groups for production and marketing in the northeastern US, specifically in Massachusetts. The targeted potential consumers for these leafy greens are three ethnic groups living on the US Eastern Seaboard, specifically Asian Indians, Chinese, and Latinos, which refers to both Mexicans and Puerto Ricans. Together, Asians and Latinos make up a large percentage of the total US population, and as they have a high per capita consumption of fresh produce, there is a large demand for specific species popular in their respective cuisines. The objectives of this research were: 1) to collect and describe growth characteristics of ethnic leaf vegetables for production and consumption in Massachusetts, 2) to assess the yield performance and establish the field viability of selected leafy greens, 3) to asses marketing opportunities for the most promising leafy greens and establish the price levels that potential consumers are willing and able to pay.

Production trials were conducted in 2011 and 2012 at the UMass Research Farm in South Deerfield, MA. All recorded data were examined per year by analysis of variance (F- test) by using HSD test for pair means comparisons for 12 dependents variables. After the field evaluation, Red purslane, Yellow purslane, Hierba mora-A and Hierba Mora -B were chosen and tested for potential marketing opportunities among the targeted ethnic communities.

In the 2011 trial, the six most promising and top-yielding leafy greens with potential for markets in the Northeastern US were Hierba mora-B, Dandelion, Indian sorrel, Yellow purslane, Red purslane and Amaranth. These crops had between 40,825 to 15,820 $kg \cdot ha^{-1}$ in fresh weight yield. In the 2012 trial, the six most promising and top-yielding leafy greens with potential for marketing were Red Purslane, Yellow purslane, Pak choy, Quincy choy, Lettuce lolo and Dandelion. Fresh weight was from 21,086 to 13, 482 $kg \cdot ha^{-1}$. Finally, wholesale prices, retail prices, costs per kilogram by activity, potential demand and profit per kilogram were determined with the respective marketing bill for the four chosen crops.

KEY WORDS: Leafy green, ethnic groups, production, marketing bill.

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CHAPTER 1

INTRODUCTION

1.1.Vegetable and leafy green production

Leafy greens are vegetative parts of plants with features that allow them to be consumed raw; therefore these types of crops are often produced for sale in fresh markets (USDA, 2011). Many of these crops are also highly perishable and thus have a short shelf life without proper storage (Vigneault, C., Thompson, J., Wu, S., Hui, C., and LeBlanc D. 2009). In the USA, leafy green vegetables are produced either through direct seeding or using transplants into the soil and can be harvested once or multiple times during a crop season by cutting the plants and allowing them to regrow under appropriate weather conditions (USDA, 2011). Leafy greens are also termed leaf vegetables, which refers to both mature and immature plant parts that are harvested for human consumption (FAO and WHO, 2008). In addition, fresh leafy greens are perishable and thus cooling methods are used by firms during transportation to target markets. Some leafy greens are also processed. For example, mustard greens (*Brassica juncea*) can be canned (USDA, 1994; Banerji, R. and Brown, G. 1999), chipilin (*Crotalaria longirostrata*) can be frozen (Morton, J. 1994), and pak choi (*Brassica chinensis*) can be cut and packed fresh (James, J. and Ngarmsak, T. 2010). The Some of the most common leafy greens among the United States population are lettuce, spinach, collards, kale, mustard greens, and turnip greens (USDA-NAPIAP,1994).

In 2013, FAO estimated that the average production of vegetables, including melons, in the world from 2003 to 2011 was estimated to be 1,121.3 million tons. The

majority of vegetable production during this period occurred in five countries: China, with an average of 487,335,597.44 tons; Mainland China, with 484,614,113.55 tons; India, with 86,053,744.00 tons; the USA, with 37,098,200.00 tons (3.3 % of the world production); and Turkey, with 26,223,395.00 tons.

According to the USDA (2013), 2.37% of the vegetables and melons in the world were produced by the US from 2001 to 2011, which is equivalent to 5.54% of China's total production. The country with the fourth highest production of vegetables and melons in the world was also the US, behind Nigeria in third place, India in second place, and China in first place (USDA, 2013).

The average value of fresh vegetable production in the US from 2008 to 2012 was $ 4,901.59 million, and the total average including both canned and frozen potatoes and others (mushrooms, dry peas, dry beans, and dry and dehydrated seeds) but not including melons was $ 9,176.82 million. With the exception of legumes, all of the vegetable categories have had a decrease in per capita consumption in the US; for example, fresh vegetable per capita consumption decreased 7% from 2000 to 2010. In 2013, the per capita consumption of all vegetable categories was estimated to be 406 pounds, and it is also expected to grow 1% every year through 2022 according to the USDA - Economic Research Service (2013). In 2012, following potatoes and melons, vegetables with the largest quantities produced in the US were of lettuce (*Lactuca sativa*) 108,138 hectares, sweet corn (*Zea mays* L. var. rugosa Bonaf.) 98,644 hectares, broccoli (*Brassica oleracea* var. botrytis) 51,174 hectares, tomatoes (*Solanum lycopersicum* L.) 38,340 hectares, green beans (*Phaseolus vulgaris*) 37,773 hectares, carrots (*Daucus carota* subsp. Sativus)

28,421 hectares, and bell peppers (*Capsicum annuum*) 22,470 hectares (Boriss, H. and Brunke, H. 2012; USDA, 2013).

The average production of leafy greens in the world has increased substantially from 125,000 tons in 1999 to 275,000 tons in 2004, which is an increase of 120% during this period. This can be seen in the 218% increase of lettuce harvesting area from 1986 to 2006 and the 300% increase in spinach harvesting area during the same period (FAO and WHO, 2008).

The second largest lettuce and chicory producer in the world was the US with an average production of 4,331,615.33 tons, while China was the largest producer with 26,756,340.45 tons of lettuce and chicory from 2003 to 2011 (FAOSTAT, 2013). The US also occupied second place in world spinach production, with an average production of 375,756.33 tons from 2003 to 2011 and with a production increase of 14.27% during this period. In the US, the three states with the largest acreage production of vegetables for fresh markets are California with approximately 324,000 hectares, Florida with close to 92,000 hectares, and Idaho with nearly 73,000 hectares. In 2007, the Census of Agriculture recorded that a total of 30% of the acres of produce harvested for fresh markets were planted in California. The most important leafy green in the US is lettuce in its many different types, spinach, cabbage and celery. The details on area of production in hectares and values from 2001 to 2012 are shown by Table 1.1 below.

Table 1.1. Harvested hectares and value of production of major leafy greens produced in the US

Year	Head lettuce *(Lactuca sativa)*		Romaine lettuce *(Lactuca sativa)*		Leaf lettuce *(Lactuca sativa)*		Cabbage *(Brassica oleracea or variants)*		Spinach *(Spinacia oleracea)*		Celery *(Apium graveolens var. dulce)*	
	Hectare	$ 1,000	Hectare	$ 1,000	Hectare	$ 1,000	Hectare	$ 1,000	Hectare	$ 1,000	Hectare	$ 1,000
2001	74,615	1,234,981	21,498	290,934	20,445	313,621	31,186	332,554	10,709	112,068	11,255	272,391
2002	74,696	1,435,296	23,603	466,896	21,822	452,274	30,640	307,856	12,834	158,385	10,972	239,846
2003	74,939	1,235,193	30,162	607,078	23,239	420,546	29,575	289,397	13,717	187,711	11,134	258,965
2004	73,279	1,118,970	30,040	492,208	24,049	430,904	29,494	311,997	14,818	127,722	11,296	288,791
2005	71,822	1,011,976	23,644	375,005	23,036	463,995	29,028	311,001	17,206	161,732	10,850	259,309
2006	72,389	1,054,941	34,980	593,866	22,632	463,859	28,036	324,365	14,777	180,774	11,215	350,454
2007	65,506	1,247,941	33,360	655,533	22,105	373,692	27,955	386,373	12,915	163,952	11,498	408,001
2008	60,202	1,063,132	31,336	479,006	21,174	411,719	26,623	355,065	14,445	193,052	11,457	369,684
2009	54,656	1,121,724	30,810	612,716	19,879	458,765	26,437	341,798	14,818	269,424	11,538	404,039
2010	53,441	1,057,504	32,105	655,659	20,729	499,538	27,004	396,432	13,077	245,985	11,336	371,153
2011	52,834	1,142,267	33,158	886,342	19,190	413,484	24,858	363,933	13,320	247,182	11,417	381,780
2012	51,255	805,658	34,980	621,771	20,526	444,082	24,737	388,600	14,170	223,622	11,741	366,404

Sources: USDA statistics 2013.

Lettuce production in the US, concentrated in both California and Arizona, accounted for more than 90% of total lettuce production in the country. The total land farmed with lettuce in 2012 was 107,000 hectares, resulting in 85.4 million of cwt equivalent to $1.9 billion. The US has exported lettuce consistently to countries such as Canada, Mexico and others. Although Spain is the largest exporter of lettuce in the world, the US is the second largest exporter as seen in 2010 when the US exported $439.3 million worth of lettuce equivalent to 327,268 metric tons (USDA-Foreign Agriculture Services, 2011). In 2013, the USDA Economic Research Service predicted that US vegetable exports were expected to increase from 5.3 billion in 2010 to 8.2 billion in 2022, with an increase of 54.72% although the vegetable imports into the US were also expected to grow from 8.8 billion in 2010 to 15.8 billion in 2022, representing an increase of 85.9%. Below, Table 1.2 shows the quantities of leafy greens exported from the US from 2000 to 2012.

Table 1.2. Selected vegetables, fresh market: U.S. exports, 2000-2012

Year	Brocoli (*Brassica oleracea L.* var italica Plenck)	Cauliflower (*Brassica oleracea* var. botrytis)	*Celery (Apium graveolens var. dulce)*	Lettuce (*Lactuca sativa*)		Green beans (*Phaseolus vulgaris*)	Cabbage (*Brassica oleracea* or variants)	Spinach (*Spinacia oleracea*)	Sweet Peas (*Lathyrus odoratus*)
				Head	Others				
1,000 kilograms									
2000	180,866	73,629	119,019	170,107	166,984	31,066	38,705	19,512	7,299
2001	158,765	78,887	113,263	172,177	177,475	25,384	38,867	25,031	5,552
2002	155,927	87,976	112,618	193,604	212,270	23,947	41,253	28,791	5,194
2003	141,483	84,935	118,291	206,173	197,095	23,190	44,870	28,152	2,740
2004	143,326	82,831	120,960	216,533	222,636	37,242	39,350	25,302	3,721
2005	143,050	84,949	122,370	204,597	221,050	35,562	42,665	21,530	3,248
2006	138,765	81,796	116,038	165,411	209,530	28,076	42,102	17,175	3,607
2007	141,355	82,740	118,054	160,534	206,101	25,722	25,310	17,911	3,665
2008	137,638	87,845	116,295	153,823	211,865	26,487	24,004	21,046	6,521
2009	118,700	89,210	115,791	119,275	201,144	31,013	25,820	26,120	5,421
2010	136,057	106,414	118,472	135,986	191,970	21,327	27,292	26,889	6,406
2011	107,952	129,480	118,539	134,662	210,750	18,457	31,090	25,585	5,574
2012	134,219	149,331	129,200	140,882	218,547	22,285	40,945	27,510	5,813
Average per crop	141392	93848	118378	167213	203647	26905	35559	23889	4982

Sources: USDA statistics 2013

Nevertheless the US has a shortage in supplying almost all of types of vegetable crop (fresh and processed) for internal demand, including leafy greens and herbs, and therefore must import vegetables to meet the demand. From 2009 to 2012, the largest exporters of vegetable to the US were Mexico (47.47%), Canada (22%), China (7%) and Peru (5.46%) which together represented 82% of the total average imports of vegetable crops.

Specifically related to imports of fresh vegetables exclusively for fresh markets, the major exporters to the US are Mexico, Canada, Peru, Guatemala, the Netherlands, and Chile. Table 1.3 below reveals the details, and it is clear that Mexico, Canada, and Peru increased their value on exportation to the USA from 2005 to 2011 while Guatemala did the same from 2008 to 2011.

Table 1.3. Selected vegetables, fresh market: U.S. import value from selected countries and the world, 2005-2012

Year	Mexico	Canada	Peru	Guatemala	Netherlands	Chile	Other countries	World
	---------- *$ 1,000* ----------							
2005	2,293,809	545,940	139,625	NA	69,746	10,174	270,582	3,329,877
2006	2,566,691	634,345	156,864	NA	69,893	7,393	316,737	3,751,923
2007	2,804,017	614,632	191,921	NA	45,670	12,977	388,015	4,057,232
2008	2,975,325	669,124	183,393	115,407	41,306	8,501	205,924	4,198,979
2009	2,906,269	620,267	196,768	142,877	56,573	5,143	193,146	4,121,043
2010	3,669,876	744,636	236,931	127,869	59,239	12,336	257,395	5,108,282
2011	4,048,868	764,365	230,240	184,931	68,361	9,957	250,697	5,557,418
2012	3,844,537	733,710	264,838	73,204	48,272	6,593	226,972	5,198,126

Fresh crops imported: Asparagus, Beans (snap/green), Broccoli, Cabbage, Cantaloupe, Carrots, Cauliflower, Celery, Sweet Corn, Cucumber, Eggplant, Garlic, Lettuce (all types), Onions, Okra, Green peas, Bell peppers, Chile Peppers, Squash, Tomatoes, and Watermelon.

1.2.Population and Ethnicity

The 2010, US Census Bureau reported that the total US population was 309 million people, up by almost 10% from 2000. The population in Massachusetts grew by 3.1% while the population of New England increased by 3.6% during this same period.

In 2010, the US Census reported 50.5 million Latinos living in the United States, representing 16.3% of the overall population; this was an increase of 43% from 2000. The Mexican population increased by 54.1%, and the Puerto Rican population increased by 35.7% in the period from 2000 to 2010. The Census also reported that the largest Latino communities living in the USA were the following: the Mexican community with 31,798, 258 people, which represented 63% of the Latino population; the Puerto Rican community with 4,623,716 people, which represented 9.2%; the Central American community with 3,998,280, which represented 7.9%; and the Cuban community with 1,785,547, which represented 3 % of the total US Latino population in 2010.

The Asian population in 2010 was 14.7 million, representing 4.8% of the overall population in the USA. According to the Census, the Asian population also increased 43% from 2000 to 2010. The Chinese population in the United States increased by 37.6

% from 2000 to 2010, while the Asian Indian population increased by 69.4% in the same period. Moreover, the Census reported the largest Asian communities living in the USA, which are the following: the Chinese community with 3,347,229 people, which represented 22.8% of the overall Asian population; the Asian Indian community with 2,843,391 people, which represented 19.4 %; the Filipino community with 2,555,923, which represented 17.4%; the Vietnamese community with 1,548,449 people, which represented 10.6%; and the Korean community with 1,423,784, which represented 9.7% of the total US Asian population in 2010.

Ethnic communities, such as Latino and Asian have contributed in the growing of the US population currently. Ethnicity refers to a group of people who have the same nationality, and share a common heritage and culture (Waters, C.M. 1990). Conversely, race is popularly defined as a socially constructed concept associated with biological differences among groups that are differentiated by external characteristics (Foster, M.W. and Sharp, R. 2014).

An ethnic group preserves several features interconnected with one another. Members of an ethnic group contribute to the development of its community, whereby community members share interest in a homeland, a common language, and traditions, including food preferences (Council of National Psychological Associations for the Advancement of Ethnic Minority Interests, 2009).

The 2010 US Census categorizes race into two dimensions: historical racial groups, e.g. African Americans, and national origin groups such as Native Americans or Alaska Natives, Asians, Native Hawaiians or Pacific Islanders (Census Bureau, 2010).

1.3.Growth of ethnic markets

The growth of immigrant groups living in the United States represents an opportunity for farmers to grow fresh Latino and Asian produce desired by these two groups. Both Asians and Latinos tend to consume more fruits and vegetables than Caucasian or White and African Americans in the United States. In 2009, the annual spending on fresh produce for Caucasians in the US was $439 per person; however, for Asian Americans it was $695 and for Latinos it was $496, while for African Americans it was $287 (Cook, 2011).

Latinos and Asians represent 21.1% of the U.S. population, occupying an important segment of the market for fresh produce. In an interesting study, Geisler, M. (2012) reported that in 2009 the Hispanic buying power was $978 billion and is projected to be $ 1.3 trillion by 2014, while the Asian American buying power totaled $509 billion in 2009 and is expected to increase to $697 million by 2014. To respond to the high demand for ethnic vegetables, the UMass Ethnic Crops Program has implemented research to establish sustainable production practices for fresh vegetables and herbs popular among the growing Latino and Asian immigrant groups (Mangan et al, 2009).

Accounting for all marketing channels, the sales of the fresh produce industry in the US reached $122.1 billion during 2010 (Cook 2011). The crops selected for this project have been identified as popular ingredients in the ethnic groups' cuisines, increasing the interest for a potential market under this initiative. Based on previous information obtained by researchers of UMass, these particular crops may have potential for production in Massachusetts. Beginning in 2011, UMass has been working with researchers at Rutgers University and the University of Florida to evaluate the production

of leafy greens popular among four immigrant groups on the US Eastern seaboard: Asian Indians, Chinese, Mexicans, and Puerto Ricans.

In order to evaluate different varieties or seed sources of leafy greens over two summers and also to test markets for the most promising crops before adoption by commercial farmers, activities related to field production and marketing were developed.

Latino and Asian ethnic groups have a high per capita consumption of fresh produce (Cook, 2011), and as a result they contribute significantly to the increased demand for ethnic produce. At the same time there is a greater emphasis on healthy foods and a desire for variety diets among consumers such as healthy 50+ American consumers ((Sloan, A.E. 2011). This provides an open opportunity to sell ethnic produce among Americans, albeit mainly organic produce (Barstow, C. 2013).

Also, farmers require research-based information on all aspects of crop production before they can produce new crops on their farms. Furthermore they need to understand ethnic preferences of consumption, establish wholesale prices of their ethnic crops, and form postharvest handling practices.

CHAPTER 2

LEAFY GREENS PRODUCTION AND EVALUATION UNDER FIELD CONDITIONS IN MASSACHUSETTS

2.1. Introduction

Leafy greens are vegetative parts of plants with features that allow them to be consumed raw and for this reason these types of crops are often produced for sale in fresh markets (USDA, 2011). Many of these crops are also highly perishable and thus have a short shelf life without proper packaging and storage (Vigneault, C., Thompson, J., Wu, S., Hui, C., and LeBlanc D. 2009). In the United States, leafy greens are either direct seeded into the soil or produced with transplants and can be harvested once or multiple times during a crop season (USDA, 2011). Leafy greens are also termed leaf vegetables, which refers to both mature and immature plant parts that are harvested for human consumption (FAO and WHO, 2008). Some leafy greens are processed. For example, mustard greens (*Brassica juncea*) can be canned (USDA, 1994; Banerji, R. and Brown, G. 1999), chipilin (*Crotalaria longirostrata*) can be frozen, (Morton, J. 1994), and pak choi (*Brassica chinensis*) can be cut and packed fresh (James, J. and Ngarmsak, T. 2010). The USDA-NAPIAP (1994) stated that some of the most common leafy greens among the United States population are lettuce (*Lactuca sativa* L.), spinach *(Spinacia oleracea* L.*),* collards (*Brassica oleracea* var viridis), kale *(Brassica oleracea* variety acephala*),* mustard greens *(Brassica juncea* L.*),* and turnip greens (*Brassica rapa* L).

In 2013, the average production of vegetables, including melons, in the world from 2003 to 2011 was estimated to be 1,121.3 million tons (FAO, 2013 and FAOSTAT, 2013). The majority of vegetable production during this period occurred in five countries:

China, with an average of 487,335,597.44 tons; China Mainland, with 484,614,113.55 tons; India, with 86,053,744.00 tons; the USA, with 37,098,200.00 tons (3.3 % of the world production); and Turkey, with 26,223,395.00 tons.

According to the USDA (2013), 2.37% of the vegetables and melons (*Cucumis melo*) in the world were produced by the US from 2001 to 2011, which is the fourth highest after China, India and Nigeria.

The average value of fresh vegetable production in the US from 2008 to 2012 was $ 4,901.59 million, and the total average including both canned and frozen potatoes (*Solanum tuberosum*), and others (mushrooms, dry peas, dry beans, and dry and dehydrated seeds) but not including melons was $ 9,176.82 million. With the exception of legumes, all of the vegetable categories have had a decrease in per capita consumption in the US. For example, fresh vegetable per capita consumption decreased 7% from 2000 to 2010. In 2013, the per capita consumption of all vegetable categories was estimated to be 406 pounds, and it is also expected to grow 1% every year through 2022 (USDA-Economic Research Service, 2013). In 2012, following potatoes and melons, vegetables with the largest quantities produced in the US were of lettuce (*Lactuca sativa*) 108,138 hectares, sweet corn (*Zea mays* L. var. rugosa Bonaf.) 98,644 hectares, broccoli (*Brassica oleracea* var. botrytis) 51,174 hectares, tomatoes (*Solanum lycopersicum* L.) 38,340 hectares, green beans (*Phaseolus vulgaris*) 37,773 hectares, carrots (*Daucus carota* subsp. Sativus) 28,421 hectares, and bell peppers (*Capsicum annuum*) 22,470 hectares (Boriss, H. and Brunke, H. 2012; USDA, 2013).

2.2. Materials and methods

In 2011 and 2012, replicated trials were conducted to evaluate the growth of leafy greens popular among immigrant groups at the University of Massachusetts Research Farm in South Deerfield, Mass. The farm has Occum fine sandy loam (coarse-loamy, mixed, mesic Fluventic Dystrudepth). The trials were set up as randomized complete block designs with four replications consisting of 16 leafy greens in 2011 and 20 leafy greens in 2012. The greens are popular among four ethnic communities, Chinese, Asian Indian, Mexican and Puerto Rican (Table 2.1.).

Seedlings of leafy greens were grown with seeds purchased from commercial companies listed in Table 2.1. In both years, all transplants were produced in a commercial greenhouse (Harvest Farm, Whately, MA) using ambient light, a temperature of 21ºC during the day and 16ºC at night until the seedlings were ready to be transplanted into the field. Seeds were started in plastic germination trays using PRO-MIX® BX (containing Canadian sphagnum peat moss-75-85%/vol., perlite-horticultural grade, vermiculite-horticultural grade, dolomitic and calcitic limestone-pH adjuster, and wetting agent) as a soiless medium. After planting, vermiculite (PRO-MIX) was placed on top. Seedlings were transplanted into plastic trays with 72 square cells (27.94 x 54.3 centimeters) when they reached approximately five centimeters in height using the same PRO-MIX® BX as soiless medium. The plants were transplanted into the field when they had three or four true leaves with an average height between 15 to 21 centimeters. All crops in the trial were put into the field as transplants, except for peas (*Pisum sativa*) and radishes (*Raphanus sativus*) which were directly seeded.

The field at the UMass Research Farm was plowed and disked before biodegradable black plastic mulch (121.93 centimeters width and 0.6 millimeters thickness, BioTelo®) was laid using a bed former to create beds that were approximately 12 cm high. The plots were 1.83 wide and 3.66 meters long. One, two or three rows of plants were transplanted per bed according to the spacing and population density determined for each crop (Table 2.1). The holes in the beds were made by hand using a bulb planter (12.5 cm depth and 7.5 cm width). Seedlings were dropped into these holes and then covered with soil up to the cotyledon. Weeds around the holes in the plastic bed were removed by hand, while weeds in-between the rows of plastic were managed with a rototiller (BCS, Boyden & Perfom, 732 GX13, Professional) and by hand. Insects and diseases were managed as needed.

For fertilization, soil tests were taken in the early spring in 2011 and 2012 and submitted to the UMass Soil and Plant Tissue Laboratory for analysis. Results of the test in 2011 were a pH of 6.5, 2.4 percent of organic matter, 10 ppm of P_2O_5, 53 ppm of K, 556 ppm of Ca, 65 ppm of Mg, and cation exchange capacity of 3.4 MEQ /100 g. Results of the soil test in 2012 were a pH of 6.6, 3.0 percent of organic matter, 22 ppm of P_2O_5, 91 ppm of K, 91 ppm of K, 702 ppm of Ca, and 84 ppm of Mg, and cation exchange capacity of 6.4 MEQ /100 g. The appropriate amounts of N, P and K were applied via drip irrigation using combinations of a complete fertilizer (20% N - 20% P2O5 - 20% K2O) and calcium nitrate (15.5% N - 0% P2O5 - 0% K2O – put in % calcium) based on the recommendations for spinach, *Spinacea oleracea*, (New England Vegetable Management Guide 2011-2012).

Water was applied via drip irrigation based on soil moisture readings from tensiometers (Irrometer Co Riverside CA.) which were placed in two randomly selected plots in the field at three depths: 15, 30, and 45cm.

Table. 2.1. Common and scientific names, year of planting, plant spacing and population, and countries where popular for leafy-greens evaluated at the UMass Research Farm in Deerfield MA in 2011 and 2012. Seed sources of companies are provided at the bottom of this table forboth years 2011 and 2012.

Common name	Scientific name	Year of planting	Spacing between plants (cm)	Spacing between rows (cm)	Number of rows per bed	Population density per hectare	Company seed sources		Countries where crops are popular for greens
							2011	2012	
Amaranth	*Amarathus tricolor*	2011, 2012	31	40	2	30,520	1	1	India, Mexico, Bangladesh, Africa, the Caribbean, India and China.
Fenugreek	*Trigonella foenium*	2011, 2012	15.5	18	3	91,800	4	4	India
Green zobo	*Hibiscus sabdariffa*	2011, 2012	61	50	2	15,498	5	5	India
Indian Sorrel	*Rumex acetosa*	2011, 2012	31	40	3	30,520	5	3	India
Radish	*Raphanus sativus*	2011, 2012	15.5	18	3	91,800	2	3	India
Red zobo	*Hibiscus sabdariffa*	2012	61	50	2	15,498	[z]NA	5	India
Chives for greens	*Alium shoenoprasum*	2012	15.5	18	3	91,800	NA	2	China and other Asian countries
Garlic chives	*Alium tuberosum*	2011, 2012	15.5	18	3	91,800	7	2	China and other Asian countries
Pok choy	*Brassica rapa* spp. chinensis	2011, 2012	31	40	2	30,520	2	2	China, Philippines, Vietnam and other East-Asian regions.
Quincy choy	*Brassica rapa* spp. chinensis	2011, 2012	31	40	2	30,520	2	2	
Sugar pea	*Pisum sativum*	2011, 2012	8	18	3	117,912	2	2	China, United States, Malawi and some Asian countries
Epazote	*Chenopodium ambrosioides*	2012	61	50	2	15,498	NA	2	Mexico
Hierba mora-A	*Solanum melanocerasum*	2011, 2012	31	40	2	30,520	8	8	Southern Mexico and Central America
Hierba mora -B	*Solanum nigrum*	2012	31	40	2	30,520	9	NA	
Magenta spreen	*Chenopodium gigantium*	2011, 2012	61	50	2	15,498	2	2	Mexico
Papalo	*Porophyllum ruderale*	2012	46	50	2	20,558	NA	2	Mexico, Bolivia
Red Purslane	*Portulaca oleracea*	2011, 2012	31	40	2	30,520	2	2	Mexico, Southern Europe
Yellow Purslane	*Portulaca oleracea*	2011, 2012	31	40	2	30,520	2	2	Mexico, Southern Europe
Dandelion	*Taraxacum officinale*	2011, 2012	31	40	2	30,520	2	6	Puerto Rico, Southern Europe
Lettuce lolo	*Lactuca Sativa*	2012	31	40	2	30,520	NA	2	Puerto Rico, many other countries
Lettuce Tropicana	*Lactuca Sativa*	2011, 2012	31	40	2	30,520	2	2	Puerto Rico, many other countries

Companies seed sources:1) Richters Herbs, 357 Durham Regional Hwy 47, Goodwood, ON L0C 1A0, Canada. **2)** Johnny's Selected Seeds, 955 Benton Ave, Winslow, ME 04901. **3)** Eden Brothers, 34 Old Brevard Road , Asheville, NC 28806. **4)** Bountiful Gardens, 1726 D South Main St, Willits, CA 95490. **5)** Seed of India, Union, NJ 07083. **6)** Local Harvest, 504 Front St, Santa Cruz, CA 95060. **7)** Evergreen Seeds, Anaheim, CA 92817. **8)** Baker Creek Heirloom, 2278 Baker Creek Road, Mansfield, MO 65704. **9)** Direct Gardening, 1704 Morrissey Drive, Bloomington, IL 61704. [z]NA: not applicable since these crops were not grown in this year.

Plant height, plant spread, leaf length and leaf width were measured weekly. For each plot, five plants were selected randomly and data were taken from these same five plants in each plot throughout the experiment. In addition, qualitative data, consisting of plant color, vigor and uniformity, using a rating scale from 1 to 5 (1 conveying the lowest values and 5 indicating the highest values), were also taken at the same time from the same selected plants. The same rating scale was used to register the presence of diseases, insects and the flowering of plants. For plots with three rows, the two side rows were considered to be a border rows and the five chosen plants were from the center row. In all plots, the plants grown in the first 61 centimeters of both ends of each plot were also considered to be borders.

For each harvest, qualitative and quantitative data were taken from the sample of five plants per plot (see Table 2.2.).

Table 2.2. Values to measure at each harvesting

Type of measurement	Measurement	Definition
Quantitative data	Plant Height (cm)	From ground surface to top of the plant
	Plant Spread (cm)	The widest point or breadth of the plant
	Leaf length (cm)	Length from base of leaf to leaf tip
	Leaf width (cm)	The widest point of the leaf
	Fresh Weight (Kg)	Fresh weight immediately after harvest.
	Dry weight (Kg)	Weight of plants after drying them for 5 days
Qualitative data (Scale from 1-5)	Plant vigor	1: low growth vigor, 5: very vigorous growth.
	Plant uniformity	1: plants lack uniformity, 5: plants very uniform.
	Disease prevalence	1: no visible disease symptoms, 5: high visible disease damage
	Insect prevalence	1: high insect presence and/or damage 5: no insect presence and/or damage.
	Days to flower	1: no plant had no visible flowers, 5: Plant had many visible flowers.

Dates of planting, days between planting and harvest, and numbers of harvests per crop were also recorded (see Table 2.3).

Table 2.3. Common name, family, planting date and harvesting details of leafy greens grown at the UMass Research Farm in Deerfield, MA in 2011 and 2012.

Common name of crop	Family	2011				2012			
		Planting date	Number of harvests	Days to the first harvest	Days to the last harvest	Planting date	Number of harvests	Days to the first harvest	Days to the last harvest
Amaranth	Amaranthaceae	06/20	3	25	52	06/01	3	27	50
Fenugreek	Fabaceae	06/13	2	39	60	06/01	1	29	NA
Green zobo	Malvaceae	06/29	1	112	NA	06/15	3	45	110
Indian Sorrel	Polygonaceae	06/13	3	32	86	06/01	4	28	64
Radish	Brassicaceae	06/10	1	22	NA[z]	06/21	3	30	115
Red zobo	Malvaceae	NA	NA	NA	NA	06/01	4	39	79
Chives for greens	Amaryllidaceae	NA	NA	NA	NA	07/25	3	35	66
Garlic chives	Amaryllidaceae	06/15	3	84	112	06/15	3	45	107
Quincy choy	Brassicaceae	06/06	1	21	NA	06/01	1	39	NA
Pok choy	Brassicaceae	06/06	1	21	NA	06/01	1	42	NA
Sugar pea	Fabaceae	06/08	2	27	42	06/03	3	36	66
Epazote		NA	NA	NA	NA	06/05	2	36	50
Hierba mora -A	Solanacea	06/13	3	25	33	06/05	3	23	55
Hierba Mora -B	Solanaceae	06/20	5	17	140	NA	NA	NA	NA
Magenta spreen	Amaranthaceae	06/15	3	26	57	06/05	4	27	69
Papalo	Asteraceae	NA	NA	NA	NA	06/03	3	30	81
Red purslane	Portulacaceae	06/15	2	26	45	06/08	3	20	40
Yellow purslane	Portulacaceae	06/15	2	26	45	06/11	3	19	43
Dandelion	Asteraceae	06/06	5	39	75	06/01	3	27	55
Lettuce lolo	Asteraceae	NA	NA	NA	NA	06/05	1	32	NA
Lettuce tropicana	Asteraceae	06/20	1	28	NA	06/01	1	37	NA

[z]NA = not applicable since only one harvest

For harvest, plants were cut ten centimeters from the soil surface when they reached marketable size, which is described for each crop in Table 2.4. The fresh weight for the five plants was then taken and samples were then put into the five pound paper bags (#20) and placed in a drier (Oven Coet Ltd, dial setting at 57.22 ˚C) for a period of five days and then the dry weight was taken using a digital scale (Ohaus, Valor 3000, Xtreme digital compact).

Table 2.4. Marketable size of crops planted in 2011 and 2012

Common name	Marketable height size for each crop
Amaranth	Harvested between 35 to 40 cm in height.
Fenugreek	Harvested between 22 to 35 cm in height.
Green zobo	Harvested between 70 to 85 cm in height.
Indian Sorrel	Harvested approximately 30 cm in height.
Radish	Harvested approximately 23 cm in height in 2011 and 60 cm in 2012.
Red zobo	Harvested at an average height of 57 cm.
Chives for greens	Harvested an average height of 31 cm.
Garlic chives	Harvested between 25 to 28 cm in height.
Pok choy	Harvested at an average height of 25cm and a width of 38 cm.
Quincy choy	Harvested at an average height of 24 cm and a width between 25 to 40 cm.
Sugar pea	Harvested between 30 to 48 cm in height.
Epazote	Harvested an average height of 62 cm.
Hierba mora- A	Harvested between 60 to 119 cm in height.
Hierba mora B	Harvested at an average height of 71 cm.
Magenta spreen	Harvested approximately 50 centimeters in height.
Papalo	Harvested at an average height of 55 cm.
Red Purslane	Harvested between 33 to 38 cm in height
Yellow Purslane	Harvested approximately 30 cm in height.
Dandelion	Harvested approximately 30 to 35 cm in height.
Lettuce lolo	Harvested an average height of 26 cm and 38 cm width.
Lettuce Tropicana	Harvested between 16 and 25 cm in height and a width between 30 to 35 cm.

The Statistical Analysis System (SAS) 9.3 program was used for the statistical analysis of these data. All recorded data from the 16 and 20 crops were examined per year by analysis of variance (F- test), using HSD test for pair means comparisons at P $\geq$0.05t in a conservative scenario.

2.3. Results

Table 2.5. shows the ANOVA results for leafy greens as a main effect in the experiment for the 12 dependent variables. Quantitative and qualitative dependent variables were examined through an analysis of variance. Dependent variables are fresh weight, dry weight, plant height, plant spread, leaf length, leaf width. Qualitative

dependent variables are plant vigor, plant uniformity, plant flower development, plant insect presence and plant disease presence.

Data obtained from 2011 and 2012 were subjected to statistical analysis using an analysis of variance procedure to test the significant effect of all the variables evaluated. Dependent variables for leafy greens planted in 2011 and 2012 were highly significant except for dry weight in 2011 which was significant (Table 2.5).

Table 2.5. Statistical differences among leafy greens as a main effect for 12 dependent variables for experiments conducted at the UMass Research Farm in Deerfield MA in 2011 and 2012.

		Leafy green main effects	
		2011	2012
Parameters	**Dependent variables**	**Probability**	**Probability**
Quantitative	Fresh weight	<.0001	<.0001
	Dry weight	0.0413	<.0001
	Plant height	<.0001	<.0001
	Plant spread	<.0001	<.0001
	Leaf length	<.0001	<.0001
	Leaf width	<.0001	<.0001
Qualitative	Plant vigor	<.0001	<.0001
	Plan uniformity	<.0001	<.0001
	Plant flower development	<.0001	<.0001
	Plant insect presence	<.0001	<.0001
	Plant diseases presence	<.0001	<.0001

Qualitative values are based on a qualitative scale, where 1 corresponds to the lowest and 5 to the highest response for each dependent variable.

Component of variance for each crop in each year expressed contribution to total significant variation. The results showed a strong impact on all of the 12 dependent variables. Means pairs comparisons were conducted by the honest significant difference (HSD) using SAS statistical packages. Table 2.6 shows the significance of means comparison for quantitative and qualitative means for corps planted in 2011, and Table 2.6 shows the significance of means comparison for quantitative and qualitative means for corps planted in 2012. In general, 11 dependent variables of 16 leafy greens grown in

2011 were highly significant different, and just dry weigh resulted significant different (Table 2.6). Dependent variables of 20 leafy green grown on 2012 were highly significant different (Table 2.7).

Table 2.6. Mean comparison for quantitative variables Fresh weight (FW), Dry weight (DW), Plant height (PH), Plant spread (PS), Leaf length (LL), and Leaf width; also mean comparison for qualitative variables Plant vigor (PV), Plant uniformity (PU), Plant flower development (PF), Plant insect presence (PI), and Plant diseases presence (PD) for leafy greens planted at the UMass Research Farm in Deerfield MA in 2011.

Common name of crop	FW (kg·ha^{-1})	DW (kg·ha^{-1})	PH (cm)	PS (cm)	LL (cm)	LW (cm)	PV (1-5)	PU (1-5)	PF (1-5)	PI (1-5)	PD (1-5)
Amaranth	15,820 def	1,367 ab	41.54 de	30.76 fg	9.79 cd	7.67 b	4.08 b	4.48 abc	1.67 d	1.13 de	1.00 b
Fenugreek	2,563 h	276 b	22.51 g	9.47 i	NA[z]	NA	2.88 c	3.14 e	2.50 c	4.00 a	2.00 a
Green zobo	23,732 c	3,754 ab	85.85 b	95.44 a	12.13 c	12.59 a	5.00 a	5.00 a	1.00 e	2.13 bcde	1.00 b
Indian Sorrel	30,980 b	1,907 ab	27.10 fg	25.87 fg	21.91 b	6.47 bc	4.75 ab	4.83 ab	3.33 b	2.50 bc	1.00 b
Radish	6,273 gh	563 b	23.43 g	25.62 fgh	18.76 b	7.52 b	3.11 c	3.54 de	1.00 e	2.75 b	1.00 b
Garlic chives	7,697 gh	220 b	28.36 fg	29.46 fg	NA	NA	5.00 a	4.38 abcd	1.00 e	1.00 e	1.00 b
Pak choy	4,866 h	332 b	28.73 fg	27.56 fg	NA	NA	4.75 ab	4.03 bcde	1.00 e	2.75 b	1.00 b
Quincy choy	4,886 h	192 b	24.10 fg	24.74 gh	NA	NA	4.83 ab	4.35 abcd	1.00 e	2.45 bc	1.00 b
Sugar pea	2,640 h	242 b	29.24 fg	16.07 ih	5.66 e	3.21 e	4.13 ab	4.73 abc	2.50 c	2.25 bcd	1.00 b
Hierba mora -A	14,119 ef	2,346 ab	119.19 a	66.85 b	12.37 c	7.69 b	4.69 ab	4.67 abc	4.83 a	1.50 de	1.00 b
Hierba mora -B	36,588 ab	4,098 a	71.85 c	56.94 c	7.48 de	4.33 de	4.43 ab	4.33 abcd	5.00 a	2.75 b	1.00 b
Magenta spreen	19,588 cde	2,956 ab	49.60 d	48.91 cd	8.01 de	5.45 cd	4.42 ab	4.02 bcde	3.86 b	1.50 de	1.50 ba
Red Purslane	19,011 cde	948 b	33.70 efg	27.25 fg	5.59 e	3.02	4.32 ab	3.93 cde	1.00 e	1.38 cde	1.75 a
Yellow Purslane	21,248 cd	1,134 b	33.08 efg	31.00 fg	5.04 e	3.39 e	4.59 ab	4.26 abcd	4.75 a	2.00 bcde	1.00 b
Dandelion	40,825 a	4,268 ab	35.37 ef	41.91 de	27.99 a	6.13 bc	5.00 a	5.00 a	1.00 e	1.00 e	1.00 b
Lettuce tropicana	12,415 fg	1,136 b	25.02 fg	35.15 ef	NA	NA	5.00 a	5.00 a	1.00 e	1.00 e	1.00 b
Significance	**	*	**	**	**	**	**	**	**	**	**
HSD 0.05	6,405	11,286	11.62	9.63	3.44	1.71	0.91	0.91	0.67	1.13	0.57

NS,*,** Nonsignificant or significant at P≤ 0.05 or 0.001 respectively.

Means separation in columns by Honest Significant Differences (HDS), *P*=0.05. Letters correspond to HSD; means with the same letter are not significantly different.

Qualitative values are based on a qualitative scale, where 1 corresponds to the lowest and 5 to the highest response for each dependent variable.

[z] Data not taken

Table 2.7. Mean comparison for quantitative variables Fresh weight (FW), Dry weight (DW), Plant height (PH), Plant spread (PS), Leaf length (LL), and Leaf width; also mean comparison for qualitative variables Plant vigor (PV), Plant uniformity (PU), Plant flower development (PF), Plant insect presence (PI), and Plant diseases presence (PD) for leafy greens planted at the UMass Research Farm in Deerfield MA in 2012

Common name of crop	FW ($kg \cdot ha^{-1}$)	DW ($kg \cdot ha^{-1}$)	PH (cm)	PS (cm)	LL (cm)	LW (cm)	PV (1-5)	PU (1-5)	PF (1-5)	PI (1-5)	PD (1-5)
Amaranth	8,817 defg	1,070 b	36.53 de	47.57 defg	15.49 b	8.77 b	4.43 a	3.91 de	3.38 ab	1.37 de	1.13 b
Fenugreek	813 h	150 b	35.12 def	7.49 j	2.57 h	1.46 g	3.31 bcd	3.95 cde	2.50 ab	4.00 ab	1.06 b
Green zobo	18,916 abc	3,198 ab	69.42 a	62.15 bc	12.84 bc	11.00 a	4.60 a	4.47 abcd	3.56 a	1.44 de	1.00 b
Indian Sorrel	9,735 defg	963 b	33.85 defg	39.41	20.34 a	6.14 c	4.39 a	4.16 abcde	2.81 ab	2.01 cde	1.00 b
Radish	15,073 bcd	4,601 a	62.06 ab	31.64 ih	20.78 a	9.82 ab	3.16 cd	3.61 e	3.50 a	3.75 ab	1.00 b
Red zobo	10,892 def	1,944 b	57.21 bc	73.79 a	8.97 de	9.91 ab	4.82 a	4.79 ab	2.88 ab	2.23 cde	1.00 b
Chives for greens	1,523 h	114 b	31.62 defg	31.43 ih	NA	NA	4.75 a	4.20 abcde	2.50 ab	1.37 de	1.13 b
Garlic Chives	4,414 gh	444 b	25.53 fgh	31.16 ih	NA	NA	4.76 a	4.87 ab	4.19 a	1.00 e	1.00 b
Pok choy	14,184 cde	1,102 b	25.53 fgh	38.48 gh	NA	NA	4.90 a	4.90 a	1.00 b	4.69 a	1.00 b
Quincy choy	14,130 cde	438 b	24.19 gh	40.77 fgh	NA[z]	NA	2.94 d	4.13 abcde	1.00 b	4.94 a	1.00 b
Sugar pea	9,459 defg	628 b	48.51 c	24.41 i	5.32 fgh	3.47 ef	4.14 abc	4.08 abcde	3.63 a	3.00 bc	1.00 b
Epazote	5,097 fgh	736 b	62.52 ab	64.83 ab	4.83 gh	1.17 g	4.61 a	4.76 abc	4.50 a	1.13 de	1.00 b
Hierba mora -A	10,999 def	1,273 b	60.97 ab	58.38 bcd	11.58 cd	5.56 cd	4.63 a	4.27 abcde	3.81 a	1.19 de	1.00 b
Magenta spreen	8,539 efg	1,099 b	53.64 bc	52.12 cdef	8.43 def	4.11 def	4.76 a	4.52 abcd	3.56 a	1.58 de	1.00 b
Papalo	11,760 de	1,705 b	54.65 bc	44.28 efg	7.22 efg	4.22 def	4.78 a	4.71 abcd	1.00 b	1.56 de	1.00 b
Red purslane	23,125 a	1,648 b	37.95 d	48.87 defg	4.85 gh	2.60 fg	4.45 a	4.19 abcde	3.13 ab	1.69 cde	2.75 a
Yellow purslane	21,086 ab	1,545 b	29.00 defg	48.98 defg	4.02 gh	2.75 fg	4.77 a	4.69 abcd	3.13 ab	2.35 cd	1.31 b
Dandelion	13,482 cde	1,808 b	29.79 defg	54.35 bcde	23.72 a	5.12 cde	4.33 ba	4.04 bcde	1.05 b	1.13 de	1.00 b
Lettuce lolo	14,521 cde	423 b	26.16 efgh	38.67 gh	NA	NA	4.83 a	4.60 abcd	1.00 b	1.00 e	1.00 b
Lettuce tropicana	11,784 de	704 b	16.92 h	29.91 ih	NA	NA	4.48 a	4.28 abcde	1.00 b	1.00 e	1.00 b
Significance	**	**	**	**	**	**	**	**	**	**	**
HSD 0.05	6263	3088	10.52	11.53	3.50	1.90	1.05	0.84	2.33	1.33	0.58

NS,*,** Nonsignificant or significant at $P \leq 0.001$ respectively.

Means separation in columns by Honest Significant Differences (HDS), $P=0.05$. Letters correspond to HSD; means with the same letter are not significantly different. Qualitative values are based on a qualitative scale, where 1 corresponds to the lowest and 5 to the highest response for each dependent variable.

[z] Data not taken

Leafy green fresh yield *(kg·ha⁻¹)* for 2011 results had highly significant differences (Table 2.6), when HSD was used for pair comparison was found that differences between pair superior to 6,405 (kg·ha⁻¹) were highly significant. Related to leafy green fresh yield *(kg·ha⁻¹)* for 2012 results differences were highly significant (Table 2.7), when HSD was used for pair comparison was found that differences superior to 6,263 (kg·ha⁻¹) were also highly significant. For differences among crops in the others 11 dependent variables, same letters represent no differences, and different letters represent differences between pair comparisons, HSD value is provided to apply means pair comparison (see Table 2.6 for 2011 and Table 2.7 for 2012).

2.4. Observations

Observations for crops are organized by ethnic preference, Asian Indian, Chinese, Mexican and Puerto Rican. A germination test was conducted to determine germination rate of each crop (Table 2.8).

2.4.1. Asian India crops

2.4.1.1. Amaranth

In both 2011 and 2012, Amaranth seed had 90% germination rate (Table 2.8). In both years, the plants regrew promptly after each harvest; however, they began to flowering after the third harvest in both years. In 2011, the fresh weight of Amaranth, 15,820 kg·ha⁻¹,was statistically higher than Radish, Fenugreek, Quincy choy, Pak choy, Sugar pea, and Garlic chives; fresh weight was lower than Dandelion, Hierba mora-B, Indian sorrel, and Green zobo. In 2012, the fresh weight, 8,817 kg·ha⁻¹, was statically higher than Fenugreek and Chives for greens; fresh weight was statistically lower than

Yellow purslane, Red purslane and Green zobo. In 2011, the dry weight of Amaranth, 1,367 kg·ha^{-1}, was not statistical different than all the dry weights of crops. In 2012, there were no leafy greens that had lower dry weight than Amaranth with 1,070 kg·ha^{-1}, Radish had a higher dry weight than Amaranth. In 2011, Amaranth had higher plant vigor than Radish and Fenugreek; plant vigor was lower than Lettuce tropicana, Dandelion, Green zobo, and Garlic chives. In 2012, Amaranth had higher plant vigor than Radish, Fenugreek and Quincy choy; plant vigor was not statically lower than other crops. In 2011, Amaranth had statistically different less insect presence than Fenugreek, Indian sorrel, Radish, Hierba mora-B, Pak choy and Quincy choy; there were no crops that had significantly lower pest incidence than Amaranth. In 2012, Amaranth has lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence than Amaranth. In 2011, Amaranth had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Amaranth had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.1.2. Fenugreek

In both 2011 and 2012, Fenugreek seed had 100% germination rate (Table 2.8). In both years, the crop faced difficulties to regrew, after the first harvest; additionally, Fenugreek flowered before the first harvest and began to produce pods very early resulting in plants death. In 2011, the fresh weight of Fenugreek, 2,563 kg·ha^{-1}, was statistically lower than Dandelion, Hierba mora-B, Indian sorrel, Green zobo, Yellow purslane, Red purslane, Magenta spreen, Amaranth, Hierba mora-A and Lettuce tropican;

fresh weight was statistically similar to Garlic chives, Radish, Quincy choy, Pack choy and Sugar pea. In 2012, the fresh weight of this crop, 813kg·ha^{-1} was lower than all crops except Epazote, Garlic chives and Chives for greens. In 2011, the dry weight of Fenugreek, 276 kg·ha^{-1}, was not statistical different than all the dry weights of crops except for Hierba mora–B. In 2012, there were no leafy greens that had statistically lower dry yield than Fenugreek with 150 kg·ha^{-1}; Radish had higher dry yields. In 2011, Fenugreek did not have higher plant vigor than any crops; while Lettuce tropicana, Dandelion, Green zobo, Garlic chives, Quincy choy, Pak choy, Indian sorrel, Hierba mora-B, Hierba mora-A, Sugar pea, Yellow Purslane, Red purslane, Magenta spreen, and Amaranth had higher plant vigor. In 2012, Fenugreek had similar statistically lower plant vigor than Dandelion, Sugar pea, Radish and Quincy choy. In 2011, Fenugreek had statistically higher insect presence than all crops; there were no crops that had significantly different higher pest incidence. In 2012, Fenugreek had higher insect incidence with Quincy choy, Pak choy, Radish and Sugar pea. In both years, this crop was not suited for production in Massachusetts because of a serious infestation of potato leaf hopper (*Empoasca fabae*), resulting in browning and necrosis along the margins of Fenugreek leaves. This insect can be a serious pest due to few management options. In 2011, Fenugreek had higher disease incidence similar to Red purslane and Magenta spreen. In 2012, Fenugreek had lower disease incidence than Red purslane; there were no crops that had lower disease incidence, statistically.

2.4.1.3. Green zobo

In 2011, Green zobo had 100% germination rate, and in 2012 the crop had 94% germination rate (Table 2.8). In 2011, this crop did not bloom; however, it started to produce flowers close to the third harvest in 2012, but it does not affect significantly the quality of its leaves. In 2011, the fresh weight of green zobo, 23,732 kg·ha^{-1}, was statistically higher than Hierba mora -A, Lettuce tropicana, Garlic chives, Radish, Quincy choy, Pak choy, Sugar pea and Fenugreek; fresh weight was lower than Dandelion, Indian sorrel and Hierba mora-B. In 2012, the fresh weight of Green zobo, 18,916 kg·ha^{-1}, was statically higher than Lettuce tropicana, Pápalo, Hierba mora-A, Red zobo, Indian sorrel, Sugar pea, Amaranth, Magenta spreen, Epazote, Garlic chives, Chives for greens, and Fenugreek; there were no crops statistically higher than Green zobo. The fresh weight of this crop was not statistically different than Red purslane, Yellow pruslane, Radish, Lettuce lolo, Pak choy and dandelion. In 2011, the dry weight of Green zobo, 1,367 kg·ha^{-1}, was not statistical different than all the dry weights of crops. In 2012, there were no leafy greens that had lower or higher dry yield than Green zobo with 1,070 kg·ha^{-1}. In 2011, Green zobo had higher plant vigor than radish and Fenugreek, and there were no crops with higher plant vigor. In 2012, the crop had higher plant vigor than Fenugreek, Radish and Quincy choy, and there were no crops with higher plant vigor. In 2011, there were no crops that had lower insect incidence than Green zobo, and it had statistically lower insect presence than Fenugreek. Green zobo was slightly affected by Japanese flea beetle (*Popillia japonica*), in both years. In 2011, Green zobo had lower disease incidence than Fenugreek and Red purslane, and there were no crops with lower

incidence of diseases. In 2012, Green zobo had lower disease incidence than Red purslane. There were no crops that had lower disease incidence.

2.4.1.4. Indian sorrel

In 2011, Indian sorrel had 30% germination rate, and in 2012 the crop had 94% germination rate (2.4.1). In both years, a vigorous regrew was observed after each harvest; however, after the second harvest some plants flowered, reducing foliage quantity. In 2012, the crop flowered entirely after the fourth harvest, reducing quality and quantity of foliage. In 2011, the fresh weight of Indian sorrel, 30,980 $kg \cdot ha^{-1}$, was statistically lower than Dandelion, similar to Hierba mora-A, and higher the all others crops. In 2012, the fresh weight, 9,735 $kg \cdot ha^{-1}$, was statically higher than Chives for greens and Fenugreek; fresh weight was statistically lower than Red purslane, Yellow purslane and Green zobo. In 2011, the dry weight of Indian sorrel, 1,907 $kg \cdot ha^{-1}$, was not statistical different than all dry weights of all of the crops. In 2012, there were no leafy greens that had lower dry weight than Indian sorrel with 963 $kg \cdot ha^{-1}$; however, Radish had a higher dry yield than this crop. In 2011, Indian sorrel had higher plant vigor than Radish and Fenugreek; there were no crops with higher plant vigor. In 2012, Indian sorrel had higher plant vigor than Radish, Fenugreek and Quincy choy. In 2011, Indian sorrel had less insect presence than Fenugreek. This crop had higher insect incidence than Amaranth, Lettuce tropicana, Dandelion and Garlic chives. In 2012, Indian sorrel had lower insect incidence than all other crops; however, Quincy choy, Pak choy and Radish had higher insect incidence than Indian sorrel. Nonetheless, in both years, there was observed damage from Japanese beetles (*Popillia japonica*); Japanese beetles feed on leaf

tissue between veins, turning the leaf appearance a lace-like without commercial value. In 2011, Indian sorrel had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Indian sorrel had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.1.5. Radish for greens

In 2011, Radish had 95 % germination rate, and in 2012 the crop had 94% germination rate (Table 2.8). In 2011 the crop was harvested with root system, a vast variation of roots colors was observed (white, purple and red). In 2012, plants regrew promptly after each harvest; however, they began to flowering after the third harvest. In 2011, the fresh weight of Radish, 6,273 kg·ha^{-1},was not statistically higher than any crop; fresh weight was lower than Dandelion, Hierba mora-B, Indian sorrel, Green zobo, Yellow purslane, Magenta spreen, Red purslane and Hierba mora-A. In 2012, the fresh weight, 15,073 kg·ha^{-1}, was statically higher than Magenta spreen, Epazote, Garlic chives, Chives for greens and Fenugreek; fresh weight was statistically lower than Red purslane. In 2011, the dry weight of Radish, 563 kg·ha^{-1}, was not statistical different than all the dry weights of crops, except for Hierba mora-B that had higher dry yield. In 2012, there were no leafy greens that had higher dry yield than Radish with 4,601 kg·ha^{-1}, all of them were lower. In 2011, Radish had lower plant vigor among all other crops. In 2012, Radish had lower plant vigor than all other crops, except for Fenugreek that had plant vigor statistically similar. In 2011, Radish had higher insect presence than Red purslane, Magenta spreen, Hierba mora-A, Lettuce tropicana, Dandelion and Garlic chives; only Fenugreek had higher insect presence than Radish. In 2012, Radish had higher insect

incidence than all other crops. In 2012, the crop suffer a severe infestation from crucifer flee beetle (*Phyllotreta cruciferae*) which almost kill the crop. However, after the second harvest the crop became strong and healthy. In 2011, Radish had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Radish had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.1.6. Red zobo

In 2012, Red zobo seed had 100% germination rate (Table 2.8). The crop regrew very well after each harvest; additionally, Red zobo started to bloom after the third harvest, but it does not affect significantly the quality of its foliage. The fresh weight of this crop, 10,892 $kg \cdot ha^{-1}$ was higher than Garlic chives, Chives for green and Fenugreek; fresh weight was lower than Red purslane, Yellow purslane and Green zobo. The dry weight of Red zobo, 1,944 $kg \cdot ha^{-1}$, was not statistically different than all dry weights of crops, except for radish that had higher dry yield. Red zobo had higher plant vigor than Radish, Fenugreek and Quincy choy, and there were no crops with higher plant vigor. The crop had lower insect presence than Quincy choy, Pack choy, Fenugreek and Radish. There were no crops with lower insect incidence than Red zobo. However, Japanese flea beetle (*Popillia japonica*) was observed on the foliage without making any significant damage. This crop had lower disease incidence than Red purslane; there were no crops that had lower disease incidence, statistically.

2.4.2. Chinese crops

2.4.2.1. Chives for greens

In 2012, Chives for greens seed had 92% germination rate (Table 2.8). This crop grew well, even though seedlings grew slowly at the beginning, perhaps due to it was transplanted at the end of July. After the second harvest the crop started to bloom, and by the third harvest haft of the plants were flowered. The fresh weight of Chives for greens, 1,523 kg·ha^{-1}, was statistically lower than all other crops, except for Epazote, garlic chives and Fenugreek that were similar. The dry weight of Garlic chives, 114 kg·ha^{-1}, was not statistical different than all dry weights of crops, except for radish that had higher dry weigh. Chives for greens had higher plant vigor than Radish, Fenugreek and Quincy choy, and there were no crops with higher plant vigor than Chives for green. The crop had less insect presence than Quincy choy, Pak choy, Fenugreek and Radish; there were no crops that had significantly lower insect incidence than Chives for greens. This crop had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.2.2. Garlic chives

In 2011, Garlic chives germination rate was not taken, and in 2012 the crop had 88% germination rate (Table 2.8). At the beginning in both years, it grew very slowly, until the first harvest, but after that regrew rapidly. No flowers were observed in 2011; nonetheless, in 2012, the crop entirely bloomed after the third harvest. In 2011, the fresh weight of Garlic chives, 7,697 kg·ha^{-1},was statistically lower than all of the crops, except Lettuce tropicana, for Radish, Quincy choi, Pack choy, Sugar pea and Fenugreek that

were statistically similar; fresh weight was lower than Dandelion, Hierba mora-A, Indian sorrel, Green zobo, Yellow purslane, Magenta spreen and Red purslane. In 2012, the crop fresh weight, 4,414 kg·ha^{-1}, was statically similar to Indian sorrel, Amaranth, Sugar pea, Magenta spreen, Epazote, Chives for greens and Fenugreek; fresh weight was lower than Red purslane, Yellow purslane, Green zobo, Radish, Lettuce lolo, Pok choy, Quincy choy, Lettuce tropicana, Hierba mora-A, Dandelion, Pápalo and Red zobo. In 2011, the dry weight of Garlic chives, 220 kg·ha^{-1}, was lower than Hierba mora-B, but there were no more crops with higher dry yield than Garlic chives. In 2012, Garlic chives dry weight, 444 kg·ha^{-1}, was lower than Radish, and there were no more crops with higher dry yield than Garlic chives. In 2011, Garlic chives had higher plant vigor than Amaranth, Radish and Fenugreek. In 2012, Garlic chives had higher plant vigor than Radish, Fenugreek and Quincy choy. In 2011, Garlic chives had lower insect presence than Fenugreek, Radish, Hierba mora-B, Pak choy, Indian sorrel, Quincy choy and Sugar pea; there were no crops that had significantly lower insect incidence than Garlic chives. In 2012, Garlic chives has lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, Sugar pea and Yellow purslane; there were no crops that had statistically lower insect incidence than Garlic chives. In 2011, Garlic chives had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Garlic chives had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.2.3. Pak choy

In 2011, Pak choy had 100 % germination rate, and in 2012 the crop had 92% germination rate (Table 2.8). In 2011, the fresh weight of Pack choy, 4,866 $kg \cdot ha^{-1}$,was statistically lower Dandelion, Hierba mora-B, Indian sorrel, Green zobo, Yellow purslane, Magenta spreen, Red purlane and Lettuce tropicana; fresh weight was similarly lower than Garlic chives, Radish, Quincy choy, Sugar pea and Fenugreek. In 2012, the fresh weight, 14,184 $kg \cdot ha^{-1}$, was statistically higher than Epazote, Garlic chives, Chives for greens and Fenugreek; fresh weight was statistically lower than Yellow purslane and Red purslane. In 2011, the dry weight of Pak choy, 332 $kg \cdot ha^{-1}$, was lower than Hierba mora-A, and there were no more crops with higher dry yield than Pak choy. In 2012, dry weigh of Pak choy, 1,102 $kg \cdot ha^{-1}$, was lower than Radish, and there were no more crops with higher dry yield than this crop. In 2011, Pak choy had higher plant vigor than radish and Fenugreek; there were no crops with lower plan vigor than Pak choy. In 2012, Pack choy had higher plant vigor than Fenugreek, Radish, and Quincy choy; there were no crops with plant vigor higher than Pak choy. In 2011, Pak choy had lower insect incidence than Fenugreek; and also this crop had higher insect incidence than Red purslane, Magenta spreen, Hierba mora-A, Amaranth, Lettuce tropicana, Dandelion, and Garlic chives. In 2012, Pak choy has higher insect incidence than Sugar pea, Yellow purslane, Indian sorrel, Red zobo, Red purslane, Magenta spreen, Pápalo, Green zobo, Amaranth, Chives for green, Hierba mora-A, Dandelion, Epazote, Lettuce tropicana, Garlic chives, and Lettuce lolo; there were no crops that had statistically lower insect incidence Pak choy. It was observed a severe attack from crucifer flea beetle (*Phyllotreta cruciferae*) and striped flea beetle (*Phyllotreta striolata*), in both growing seasons. In

2011, Pak choy had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Pak choy had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.2.4. Quincy choy

In 2011, Quincy choy had 100 % germination rate, and in 2012 the crop had 96% germination rate (Table 2.8). In 2011, the fresh weight of Quincy choy, 4,886 $kg \cdot ha^{-1}$,was statistically lower than Dandelion, Hierba mora-B, Indian sorrel, Green zobo, Yellow purslane, Magenta spreen, Red purlane and Lettuce tropicana; fresh weight was similarly lower than Garlic chives, Radish, Pak choy, Sugar pea and Fenugreek. In 2012, the fresh weight, 14,130 $kg \cdot ha^{-1}$, was statically higher than Epazote, Garlic chives, Chives for greens and Fenugreek; fresh weight was statistically lower than Yellow purslane and Red purslane. In 2011, the dry weight of Quincy choy, 192 $kg \cdot ha^{-1}$, was lower than Hierba mora-A, and there were no more crops with higher dry yield. In 2012, dry weigh of Quincy choy, 438 $kg \cdot ha^{-1}$, was lower than radish, and there were no more crops with higher dry yield. In 2011, Quincy choy had higher plant vigor than Radish and Fenugreek; there were no crops with lower plan vigor than Quincy choy. In 2012, Quincy choy had lower plant vigor than all of the crops and only similar to Fenugreek and Radish. In 2011, Quincy choy had lower insect incidence than Fenugreek; and also this crop had higher insect incidence than, Magenta spreen, Amaranth Hierba mora-A, Lettuce tropicana, Dandelion, and Garlic chives. In 2012, Quincy choy has higher insect incidence than Sugar pea, Yellow purslane, Indian sorrel, Red zobo, Red purslane, Magenta spreen, Pápalo, Green zobo, Amaranth, Chives for green, Hierba mora-A,

Dandelion, Epazote, Lettuce tropicana, Garlic chives, and Lettuce lolo; there were no crops that had statistically higher insect incidence than Quincy choy. Also, it was observed a severe attack from crucifer flea beetle (*Phyllotreta cruciferae*) and striped flea beetle (*Phyllotreta striolata*), in both growing seasons. In 2011, Quincy choy had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Quincy choy had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.2.5. Sugar pea

In 2011, Sugar pea had 100 % germination rate, and in 2012 the crop had 90% germination rate (Table 2.8). In both years, the plants faced difficulties to regrew, and the crop started to flower after the first harvest in both years. In 2011, after the second harvests, the pea tendrils lost their commercial quality. The crop also expressed sensitive to cut lesser than 10 centimeters from the soil surface. In 2011, the fresh weight of Sugar pea, 2,640 $kg \cdot ha^{-1}$,was statistically lower than most of the crops and only was similar than Radish, Garlic chives, Quincy choy, Pak choy, and Fenugreek. In 2012, the fresh weight, 9,459 $kg \cdot ha^{-1}$, was statistically higher than Fenugreek and Chives for greens; fresh weight was statistically lower than Red purslane, Yellow purslane and Green zobo. In 2011, the dry weight of Sugar pea, 242 $kg \cdot ha^{-1}$, was lower than dry yield of Hierba mora-A, weights of dry yield of all others crops were similar to Sugar pea. In 2012, the crop dry weight, 628 $kg \cdot ha^{-1}$, was lower than Radish; there were no more leafy greens dry weight higher than Sugar pea. In 2011, Sugar pea had higher plant vigor than Amaranth, Radish and Fenugreek; there were not crops with higher plant vigor. In 2012,

Sugar pea had any significant plant vigor differences with all other crops. In 2011, Sugar pea had higher insect presence than Lettuce tropicana, Dandelion, and Garlic chives; also, the crop had lower insect incidence than Fenugreek, Radish, and Hierba mora-B. In 2012, Sugar pea had lower insect incidence than Magenta spreen, Pápalo, Green zobo, Hierba mora-A, Epazote, Chives for greens, Dandelion, Lettuce tropicana, Garlic chives, and Lettuce lolo. Additionally, Sugar pea had lower insect incidence than Quincy choy and Pok choy. In 2011, Sugar pea had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Sugar pea had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3. Latino crops- Mexican

2.4.3.1. Epazote

In 2012, Epazote seed had 92% germination rate (Table 2.8). After the second harvest, it regrew but with a poor quality foliage. This crop had early bloom and produced abundant seeds and poor foliage. The fresh weight of Epazote, 5,097 $kg \cdot ha^{-1}$, was statistically similar than Hierba mora-A, Red zobo, Indian sorrel, Sugar pea, Amaranth, Magenta spreen, Garlic chives, Chives for green, and Fenugreek; there were no crops with lower yield than Epazote. The crop had lower fresh yield than Red purslane, Yellow purslane, Green zobo, Radish, Pok choy, Quincy choy, Lettuce tropicana, Lettuce lolo, Pápalo and Dandelion. The dry weight of Epazote, 736 $kg \cdot ha^{-1}$, was not statistical different than all other crops, except for radish that was greater than Epazote. This crop had higher plant vigor than Radish, Fenugreek and Quincy choy; and there were no crops with higher plant vigor. Epazote crop had less insect presence than

Quincy choy, Pak choy, Fenugreek, Radish, and Sugar pea; there were no crops that had significantly lower insect incidence than Epazote. Also, Epazote had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3.2. Hierba mora-A

In 2011, Hierba mora-A had 60 % germination rate, and in 2012 the crop had 94% germination rate (Table 2.8). In both years the crop bloomed, even at the time of the first harvest, and after the third harvest the crop seeded significantly reducing foliage quality. In 2011, the fresh weight of Hierba mora-A, 15,820 kg·ha^{-1},was statistically higher than Garlic chives, radish, Quincy choy, Pak choy, Sugar pea, and Fenugreek; fresh weight was lower than Dandelion, Hierba mora-B, Indian sorrel, Green zobo and Yellow purslane. In 2012, the fresh weight Hierba mora-A, 10,999 kg·ha^{-1}, was statically higher than Chives for greens and Fenugreek; fresh weight was statistically lower than Red purslane, Yellow purslane, Green zobo and Radish. In 2011, the dry weight of Hierba mora-A, 2,346 kg·ha^{-1}, was not statistically different than all of crops; there were no leafy greens that had lower or higher dry yield than this crop. In 2012, the dry weight of Hierba mora-A, was lower than Radish, and there were no leafy greens that had lower yields than Hierba mora-A with 1,273 kg·ha^{-1}. In 2011, Hierba mora-A had higher plant vigor than Radish and Fenugreek; there were no crops that had greater plant vigor than Hierba mora-A. In 2012, Hierba mora-A had higher plant vigor than Radish, Fenugreek and Quincy choy; there were no crop with greater plan vigor than Hierba mora-A, statistically. In 2011, Hierba mora-A had statistically less insect presence than Fenugreek, Indian sorrel, Radish, Hierba mora-B , Pak choy and Quincy choy; there were no crops

that had significantly lower insect incidence than Hierba mora-A. In 2012, Hierba mora-A had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence than Hierba mora-A. However, in both years, the crop had damage from eggplant flea beetle (*Epitrix fuscula*), but it was not severe damage on leaf foliage. In 2011, Hierba mora-A had lower disease incidence than Fenugreek and Red purslane; there were no crops that had lower disease incidence. In 2012, Hierba mora-A had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3.3. Hierba mora-B

In 2011, Hierba mora-B seed had 30 % germination rate (Table 2.8). This type of Hierba mora has tiny stems and dense foliage which made it more suitable for foliage production. The crop started to bloom early by the time before the first harvest; however, it does not affected the foliage quality and quantity. The fresh weight of Hierba mora-B, 36,588 kg·ha^{-1}, was statistically similar than Dandelion and Indian sorrel; there were no crops with higher yield than Hierba mora-B. The dry weight of Hierba mora-B, 4,098 kg·ha^{-1}, was one of the highest and only statistically similar than Green zobo, Magenta spreen, Hierba mora-A, Indian sorrel and Amaranth. Hierba mora-B had higher plant vigor than Radish and Fenugreek; and there were no crops with higher plant vigor. This crop had lower insect incidence than Fenugreek; and also it had higher insect incidence than Red purslane, Magenta spreen, Hierba mora-A, Amaranth, Lettuce tropicana, Dandelion, and Garlic chives. Hierba mora-B was more susceptible to damage from eggplant flea beetle (*Epitrix fuscula*) than the Hierba mora type A. Finally, it had lower

disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3.4. Magenta spreen

In 2011, Magenta spreen had 25 % germination rate, and in 2012 the crop had 70% germination rate (Table 2.8). In both years, Magenta spreen grew very robust and after the third harvest lost its purple color. Few flowers were observed in 2011, although in 2012 the crop fully bloomed after the fourth harvest. In 2011, some Mexicans visitors observed this crop, but they said in Mexico is used another variety called “Huauzontle”. In 2011, the fresh weight of Magenta spreen, 19,588 kg·ha^{-1}, was statistically higher than Lettuce tropicana, Garlic chives, Radish, Quincy choy, Pak choy, Sugar pea and Fenugreek; fresh weight was lower than Dandelion, Hierba mora-B and Indian sorrel. In 2012, the fresh weight, 8,539 kg·ha^{-1}, was statistically higher than Chives for greens and Fenugreek; fresh weight was statistically lower than Red purslane, Yellow purslane, Green zobo and Radish. In 2011, the dry weight of Magenta spreen, 2,956 kg·ha^{-1}, was one of the highest and only statistically similar than Green zobo, Hierba mora-B, Hierba mora-A, Indian sorrel and Amaranth. In 2012, there were no leafy greens that had lower yields than Magenta spreen with 1,099 kg·ha^{-1}; however, Radish had higher yield than all of crops. In 2011, Magenta spreen had higher plant vigor than Radish and Fenugreek; there were no crops with higher plant vigor the Magenta spreen. In 2012, the crop had higher plant vigor than radish, Fenugreek and Quicy choy; plant vigor was not statically lower than any crop. In 2011, Magenta spreen had statistically less insect presence than Fenugreek, Indian sorrel, Radish, Hierba mora-B, Pak choy and Quincy choy; there were

no crops that had significantly lower insect incidence than Magenta spreen. In 2012, Magenta spreen had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence Magenta spreen. In 2011, Magenta spreen had any significant differences of disease incidence than all of the crops. In 2012, Magenta spreen had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3.5. Pápalo

In 2012, Pápalo seed had 80% germination rate (Table 2.8). This crop grew and re-grew very well, and it can be cut multiple times, although it is very susceptible to lodging by wind. Less lodging occurred when plants were planted 30 centimeters in the row instead of 46 centimeters in demo rows. No flowers were observed. The fresh weight of pápalo, 11,760 $kg \cdot ha^{-1}$, was lower than Red purslane and Yellow purslane; fresh weigh was higher than Epazote, Garlic chives, Chives for green and Fenugreek. The dry weight of Pápaplo, 1,705 $kg \cdot ha^{-1}$, was lower than Radish; there were no crops with lower dry weight than Pápalo. Also, this crop had higher plant vigor than Radish, Fenugreek and Quincy choy; there were no crop with higher plant vigor than Pápalo. This crop had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence than Pápalo. Finally, the crop had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.3.6. Red purslane

In 2011, Red purslane had 95 % germination rate, and in 2012 the crop had 90% germination rate (Table 2.8). During 2011, there were implemented two methods of harvesting, with and without the root system. Both methods can be used; however, when the crop is harvested without root system it can be harvested multiple times. This crop produced several steams and it is less succulent than Yellow purslane. In 2011, the crop did not flower; however, in 2012 the crop entirely bloomed after the third harvest. In 2011, the fresh weight of Red purslane, 19,011 $kg \cdot ha^{-1}$, was statistically higher than Lettuce tropicana, Garlic chives, Radish, Quicy choy, Pak choy, Sugar pea and Fenugreek; fresh weight was lower than Dandelion, Hierba mora-B and Indian sorrel. In 2012, the fresh weight, 23,125 $kg \cdot ha^{-1}$, was statistically the highest yield and only similar than Yellow purslane and Green zobo; there were no crops with higher yield than Red purslane. In 2011, the dry weight of Red purslane, 948 $kg \cdot ha^{-1}$, was not statistically different than all of crops, except for Hierba mora-B that was higher. In 2012, there were no leafy greens that had lower dry yield than Red purslane with 1,070 $kg \cdot ha^{-1}$; however, Radish had the highest yield than all of the crops. In 2011, Red purslane had higher plant vigor than Radish and Fenugreek; no crops had greater plant vigor than Red purslane. In 2012, Red purslane had higher plant vigor than radish, Fenugreek and Quincy choy. In 2011, Red purslane had statistically less insect presence than Fenugreek, Radish, Hierba mora-B and Pak choy; there were no crops that had significantly lower insect incidence than Red purslane. In 2012, Red purslane had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence; however, in both years, this crop was susceptible to Japanese flea beetle (*Popillia japonica*). In 2011, Red purslane had higher disease incidence than all of

crops and only similar to Fenugreek and Magenta spreen. In 2012, Red purslane had the highest disease incidence; there were no crops that had higher disease incidence. Red purslane was very susceptible to fungus deseases, such as Rhizoctonia root rot and stem canker caused by strains of the soil-borne fungus (*Rhizoctonia solani*), and Leaf Speckle (*Drechslera portulacae*) which is very host specific, for symptoms and management see Appendix A and B.

2.4.3.7. Yellow purslane

In 2011, Yellow purslane had 95 % germination rate, and in 2012 the crop had 92% germination rate (Table 2.8). During 2011, there were implemented the same two methods of harvesting applied on Red purslane with the same results. This crop has one main stem and its leaves are more succulent than Red purslane. In both years, the crop bloomed after the first harvest, and it was fully flowered by the second harvest. Also, Yellow purslane seeded after the third harvest in 2012. In 2011, the fresh weight of Yellow purslane, 21,248 $kg \cdot ha^{-1}$,was statistically higher than Lettuce tropicana, Garlic chives, Radish, Quicy choy, Pak choy, Sugar pea and Fenugreek; fresh weight was lower than dandelion, Hierba mora-B and Indian sorrel. In 2012, the fresh weight, 21,086 $kg \cdot ha^{-1}$, was statistically similar than Red purslane and Green zobo; there were no crops with higher yield than Yellow purslane, statistically. In 2011, the dry weight of Yellow purslane, 1,134 $kg \cdot ha^{-1}$, was not statistical different than all of crops, except for Hierba mora-B that was higher. In 2012, there were no leafy greens that had lower dry yield than Yellow purslane with 1,545 $kg \cdot ha^{-1}$; being Radish the highest yield among all crops. In 2011, Yellow purslane had higher plant vigor than Radish and Fenugreek; no crops had

greater plant vigor. In 2012, Yellow purslane had higher plant vigor than Radish, Fenugreek and Quincy choy. In 2011, Yellow purslane had statistically less insect presence than Fenugreek; there were no crops that had significantly lower insect incidence than Yellow purslane. In 2012, Yellow purslane has lower insect incidence than Quincy choy, Pok choy, Fenugreek and Radish; additionally, Lettuce tropicana, Garlic chives, and Lettuce lolo had statistically lower insect incidence than Yellow purslane. During 2012, after the third harvest the crop began to declining in quality of their leaves, which had not commercial quality due to attack of Japanese flea beetle (*Popillia japonica*) and Aphis (*Aphis spp*) causing damage on foliage. In 2011, Yellow purslane had lower disease incidence than Red purslane. In 2012, Yellow purslane had lower disease incidence than Red purslane; nonetheless, both crop were susceptible to fungus diseases, such as Rhizoctonia root rot and stem canker caused by strains of the soil-borne fungus (*Rhizoctonia solani*), and Leaf Speckle (*Drechslera portulacae*) which is very host specific, for symptoms and management see Appendix A and B. The damages were severed on Red purslane than Yellow purslane.

2.4.4. Latino crops-Puerto Rican

2.4.4.1. Dandelion

In 2011, Dandelion had 75 % germination rate, and in 2012 the crop had 92% germination rate (Table 2.8). Dandelion grew and re-grew healthy and rapidly. In 2012, however, Dandelion growing was spread over the ground until the second harvests, when it was cutting aggressively close to the ground, after that it grew up right. Several commercial farmers in the area, especially organic ones, grow this crop. Dandelion can be harvested once per week, but dandelion foliage become bitter as crop mature. No

flowers were observed in 2011 and few plants produced flowers in 2012. In 2011, the fresh weight of Dandelion, 21,248 kg·ha^{-1}, was statistically higher than all of crops, except for Hierba mora-B that was statistically similar. In 2012, the fresh weight, 13,482 kg·ha^{-1}, was higher than Epazote, Garlic chives, Chives for greens and Fenugreek; fresh weight was lower than Red purslane and Yellow purslane. In 2011, the dry weight of Dandelion, 4,268 kg·ha^{-1}, was not statistical different than all of crops. In 2012, there were no leafy greens that had lower dry yield than Dandelion with 1,808 kg·ha^{-1}; being Radish the highest yield among all crops. In 2011, Dandelion had higher plant vigor than Radish, Fenugreek and Amaranth; no crops had greater plant vigor than Dandelion. In 2012, Dandelion had higher plant vigor than Radish, Fenugreek and Quincy choy. In 2011, Dandelion had statistically less insect presence than Fenugreek, Hierba mora-B, Radish, Quincy choy, and Sugar pea; there were no crops that had significantly lower insect incidence than Dandelion. In 2012, Dandelion had lower insect incidence than Quincy choy, Pok choy, Fenugreek and Radish. In 2011, Dandelion had statistically less insect presence than Fenugreek, Radish, Indian sorrel, Hierba mora-B, Pak choy, Quincy choy and sugar pea; there were no crops that had significantly lower pest incidence than Dandelion. In 2012, Dandelion had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence than Dandelion. In 2011, Dandelion had lower disease incidence than Fenugreek and Red purslane. In 2012, Dandelion had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.4.2. Lettuce lolo

In 2012, Lettuce lolo seed had 92% germination rate (Table 2.8). This crop grew very well. The fresh weight of Lettuce lolo, 14,521 kg·ha^{-1}, was lower than Red purslane and Yellow purslane; fresh weigh was higher than Epazote, Garlic chives, Chives for green and Fenugreek. The dry weight of Lettuce lolo, 423 kg·ha^{-1}, was lower than Radish; there were no crops with lower dry weight than Lettuce lolo. Also, this crop had higher plant vigor than Radish, Fenugreek and Quincy choy; there were no crop with higher plant vigor than Lettuce lolo. This crop had lower insect incidence than Quincy choy, Pok choy, Fenugreek, Radish, and Sugar pea; there were no crops that had statistically lower insect incidence. Finally, the crop had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

2.4.4.3. Lettuce Tropicana

In 2011, Lettuce tropicana had 55 % germination rate, and in 2012 the crop had 100 % germination rate (Table 2.8). In 2011, the fresh weight of Lettuce tropicana, 12,415 kg·ha^{-1}, was statistically higher than Quincy choy, Pak choy, Sugar pea, and Fenugreek; fresh weight was lower than Dandelion, Hierba mora-B, Indian sorrel, Green zobo, Yellow purslane, Magenta spreen and Red purslane. In 2012, the fresh weight of Lettuce tropicana, 11,784 kg·ha^{-1}, was statically higher than Epazote, Garlic chives, Chives for greens and Fenugreek; fresh weight was statistically lower than Red purslane, Yellow purslane and Green zobo. In 2011, the dry weight of Lettuce tropicana, 1,136 kg·ha^{-1}, was lower than Hierba mora-B, and there were no more crops with higher or lower dry yield than Lettuce tropicana. In 2012, the dry weight of Lettuce tropicana, 1,808 kg·ha^{-1}, was lower than radish, and there were no more leafy greens that

had lower or higher yields than Lettuce tropicana. In 2011, Lettuce tropicana had higher plant vigor than Radish and Fenugreek; there were no crops that had greater plant vigor than Lettuce tropicana. In 2012, Lettuce tropicana had higher plant vigor than Radish, Fenugreek and Quincy choy; there were no crop with greater plant vigor than Lettuce tropicana. In 2011, Lettuce tropicana had statistically less insect presence than fenugreek, Radish, Indian sorrel, Hierba mora-B, Pak choy, Quincy choy and Sugar pea; there were no crops that had significantly lower insect incidence than Lettuce tropicana. In 2012, Lettuce tropicana had lower insect incidence than Quincy choy, Pak choy, Fenugreek, Radish, Sugar pea and Yellow purslane; there were no crops that had statistically lower insect incidence than Lettuce tropicana. In 2011, this crop had lower disease incidence than Fenugreek and Red Purslane; there were no crops that had lower disease incidence. In 2012, the crop had lower disease incidence than Red purslane; there were no crops that had lower disease incidence.

Table 2.8. Germination rate and leafy external features for leafy greens grown at the UMass Research Farm in Deerfield MA in 2011 and 2012

Crop	Germination %		Leaf color	Leaf texture	Leaf surface	Flower color	Aroma strength	Taste
	2011	2012						
Amaranth	90	90	Purple, green and red	Crunchy and hard	Veiny	Yellow, red and purple	Medium	Sour
Fenugreek	100	100	Frosty green	highly crunchy	Soft	white	Medium	Better
Green zobo	100	94	Dark green	Smooth and crunchy	Palm pattern -Spotting on edges	Purple, red and pink	Medium	Sour
Indian Sorrel	30	94	Green	Grainy and round	Cup, center vein and edges frilly	Red dish and purple	Mild	Sour
Radish	95	94	Green	Furry	Center vein	Purple and white	Medium	Bitter and slightly spicy
Red zobo	NA	100	Purple red and dark green	Smooth crunchy	Spotting on edges	Purple and red	Medium	Sour
Chives for greens	NA	92	Green	Rubbery	Spotting	White	Strong like onion	
Garlic chives	NA	88	Green	crunchy and rubbery		white	strong as garlic	
Pak choy	100	92	Dark green	Smooth	Flat	No	No	
Quincy choy	100	96	Light green	Smooth	Flat	No	No	
Sugar pea	100	90	Light green	Smooth	Waxy	White, yellow and purple	No	Sweet
Epazote	NA	80	Green	Smooth crunchy	-Serrated edges	Yellow light green	Strong mint	
Hierba mora A	60	94	Dark green	Veiny and soft		White	Medium	
Hierba mora B	30	NA	Green	Veiny and soft	Soft	White	Medium	
Magenta spreen	25	70	Green, purple and red	Crunchy and hard	Veiny	Yellow and purple	Medium	Sour
Papalo	NA	80	Green	Smooth and soft	highly crunchy with oil	No	high and strong	
Red purslane	95	90	Green	Soft and succulent	Soft	Yellow	Mild	Sour and lemony
Yellow purslane	95	92	Green yellowing	Smooth and soft	Shiny and crunchy	Yellow	Medium	Sour
Dandelion	75	92	Dark green	Strong crunchy	Elongated blade and sawn	Yellow	Medium	Bitter
Lettuce lolo	NA	92	Dark green	Edge curve	Rounded leaf cup-shaped	No	NO	
Lettuce tropicana	55	100	Light green	Edge curve	Rounded leaf cup-shaped	No	No	

2.5. Discussion

Discussion on leafy greens is detailed according to each year trial. The discussion is focused on fresh weight, since this is how these crops are sold, and their potential for field production and marketing opportunities.

2.5.1. Production trial of 2011

Leafy greens that were harvested five times, such as Hierba mora-B and Dandelion, were the crops that produced the highest yield. Both crops do not require intense labor for harvesting, which translates to less labor. Harvesting represents one of the highest costs in crop production cost (Wiswall, R. 2009). In addition, these two leafy greens kept their high level of crop vigor throughout the season. Some of these crops can be direct seeded or transplanted; leafy greens that are started in a greenhouse and transplanted into the field leads to more cuttings and high yields compared to direct seeding. Indian sorrel is another crop that can be managed similar to Dandelion; its yield was similar to Hierba mora-B. The leaf quality of Hierba mora declined after 30 days of growth; better results were obtained when this crop was harvested before 25 days after transplant. Hierba mora B needs to be monitored regularly for Eggplant flea beetle (*Epitrix fuscula*) and Indian sorrel for Japanese beetle *(Popillia japonica)*. These insects can cause severe damage in foliage of those crops.

Dandelion, Hierba mora B and Indian sorrel have market potential in niche markets and they can be produced under Massachusetts conditions. Green zobo also had one of the highest yields, although further research will be needed to demonstrate its potential for field production and marketing. This crop is a perennial and its flowers are used to prepare different beverages in Latin America, and the leaves are used in

Myanmar, India and Thailand (Van Wik, B. 2013). Green zobo may need a different environment than Massachusetts to produce mature flowers. Based on these trials, it can only be produced for its leaves under Massachusetts conditions.

The quality of fresh foliage of Yellow purslane, Magenta spreen, Red purslane and Amaranth was good without major differences in yield among them. Yellow purslane, Red purslane and Amaranth show promise to be viably produced and marketed in Massachusetts; however, the variety of Magenta spreen grown in this trial was not the appropriate variety for markets in Massachusetts. These markets are interested in a variety called "Huazontle" (Mangan, et al 2010; Magan, 2011).

Lettuce tropicana, Garlic chives, Radish for greens, Quincy choy, Pak choy and Sugar pea were crops that had the lowest yield; however, changes in some agricultural practices could increase yield of some of these crops. For example, the yields of Lettuce tropicana, Garlic chives, Quincy choy and Pak choy can be increased with a higher plant population. Quincy choy and Pak choy have to be weekly monitored for crucifer flea beetle ((*Phyllotreta cruciferae)* and striped flea beetle presence (*Phyllotreta striolata).* It is estimated that the overall yield of Radish for greens would be significantly higher if they were harvested multiple times instead of once. Fenugreek was seriously affected by potato leaf hopper (*Empoasca fabae*), significantly reducing its yield quality and quantity. Sugar pea did not respond positively to multiple harvests; it is recommended that this crop be harvested once.

2.5.2. Production trial of 2012

The greatest level of fresh weight was produced by Red purslane, Yellow purslane and Green zobo. The middle level of fresh weight was produced by Radish, Lettuce topicana, Pak choi,, Quincy choy, Dandelion, Lettuce Tropicana, Pápalo , Hierba mora, Red zobo, Indian sorrel, Sugar pea and Amaranth. The lowest level of fresh weight was produced by Magenta spreen, Epazote, Garlic chives, Chives for greens and Fenugreek.

Red and Yellow purslane are promising crops for different ethnic markets in Massachusetts and they can be produced under Massachusetts conditions. Hierba mora-A also can be produced in Massachusetts and can be marketed to Latinos from Central American and Southern Mexico. Green and Red zobo are perennial trees that can be produced for leafy green in Massachusetts; however, the market potential has to be determined. Japanese flea beetle (*Popillia japonica*) affects the foliage quality.

In 2012, Radish was harvested multiple times, which increased the level of production; however, its market potential as leafy green needs to be determined. As in 2011, yields of Lettuce lolo, Lettuce tropicana, Quincy choy and Pak choy, can be increased by planting more densely. These three crops are already produced and marketed in Massachusetts. Pápalo yield and quality was good; however, more information is needed on the market demand. The variety of Epazote grown in this trial was not suitable for production in Massachusetts. The plants began to produce flowers prematurely, which could be due to sensitivity to photoperiod.

Seeds sources of all of these two crops can be found in the USA, but it is important to buy the right varieties that markets niches want to buy.

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CHAPTER 3
MARKET ASSESSMENT OF PURSLANE AND HIERBA MORA

3.1. Introduction

Fresh produce commercialized in the US by market channels reached approximately $122.2 billion as a total in 2010; at the same time, importation of fresh produce totaled $12.3 billion (Cook, 2011). It is documented that the demand for ethnic fruits, vegetables, and herbs, particularly in larger cities of the US, is currently growing (Govindasamy, R. et. al, 2010), while there is also an interest among ethnic consumers in buying fresh produce and often unique ingredients required for preparing ethnic dishes at home. Additionally, in the US is a greater emphasis on healthy foods and a desire for variety diets among consumers such as healthy 50+ American consumers with a trend of ethnic food fusion of American, Latino and Asian (Sloan, A. E. 2011). This provides an open opportunity to sell ethnic produce among Americans, albeit mainly organic produce (Barstow, C. 2013).

Purslane is a succulent common leafy green in some Mediterranean and Latino American countries cuisine, that is reported hast it origin from the Western Himalayas to southern Russia, Greece (Nuez and Hernández-Bermejo, 1994; Egea-Gilabert, C., Ruiz-Hernández, M.V., Parra, M.A. and, Fernández, J.A. 2014) and the Philippines (Grieve, C.M. and Suarez D.L. 1997). Purslane as a new leafy green also has potential to diminish incidences of coronary disease mostly because it is a source of omega three fatty acids, and it also has antioxidants and vitamins (Miller et al., 1984; Simopoulos and Salem, 1986; Simopoulos et al., 1992; Cros, V., Martinez, J.J., and Franco, J.A. 2007; Gonnella, M., Charfeddine, M.,Conversa, G. and Santamaria, P. 2010).

Hierba mora as a leafy green is widespread used, particularly in Central America, southern Mexico, Africa and South East Asia. However, there is confusion over the identification of the specie utilized as a food crop, because some species may have a toxic alkaloid called solanine which causes varying degrees of poisoning in humans and livestock if it is consumed in vast quantities (Edmonds, J.M and Chweya, J. A. 1997; Ondieki, M.J., Aguyoh J.N. and Opiyo, A. 2011). Hierba mora has many culinary uses, ranging from different types of soups to stews (Recinos, M. L. 1998). In this dissertation research, it was found that in Guatemala, El Salvador and Asian Indian the Hierba mora is used as a leafy green.

Farmers markets represent an ideal place to sell Purslane and Hierba mora. Costumers usually buy leafy greens at farmers markets because they want to support local farming, if farmers supply this type of market they must have to ensure freshness, texture, look, color cleanliness, and others external characteristics to guarantee quality (Haddad, N. 2014). Additionally, attractive packaging, promotional material, recipes and communication with costumers are important to introduce a new crop.

Farmers want to sell their produce in farmers market because of retail prices are higher than wholesale prices; however, when a retail markets have decreased or reached their potential for buying, or the costs of selling at retail are too high, wholesale markets are the alternative (Worley, S. and Strobbe, M. 2012).

In this research, food marketing bill for Purslane and Hierba mora are estimated and measured by difference between total retail food dollar expenditures minus farm share, where farm share refers to the average payment that farmers obtain for their fresh commodity (Canning, P. 2012).

For farmers, profit is the most critical factor to maintain a farm business, and it needs to be planned to take important decisions on pricing strategies. Additionally, profit can be enhanced by offering the right product, at the right location, with the right price, and with adequate promotion (Seperich, G. J., W, W. M., & Beierlein, J. G. 1994; Stone, 2009). When successful revenues are increased and cost decreased.

To provide leafy green and herbs to ethnic communities living in the Western of the US, it is important to understand desires, needs, and behavior on purchasing produce. Also the business needs to be profitable in the long term (Rogers, R. 2014).

As has been defined before, this proposal focuses on the opportunity to grow and market ethnic leafy greens to enhance profitability of small and medium sized farms on the east coast of the US. After the field evaluation of 16 different leafy greens cultivated at the UMass research farm in 2011 and 20 cultivated in 2012, two purslane (*Portulaca oleracea*) types were tested for potential marketing opportunities among the targeted ethnic communities of this project during 2011, 2012, and 2013. In addition, two types of hierba mora (*Solanum nigrum and Solanum melanocerasum*) were planted in 2011 for a preliminary marketing research study. In the end four crops were selected: Red purslane, Yellow purslane, Hierba mora-A (garden huckleberry) and Hierba mora-B to conduct a marketing assessment based on potential demand and adaptation to Massachusetts field conditions. The marketing assessment was conducted in four phases:

- Marketing field trip and initial sales in 2011
- First attempt at marketing in 2012
- Expanded attempt at marketing in 2013
- Calculate the marketing bill and profit of selected crops in 2014

3.2. Marketing field trip and initial sales in 2011

An initial and quick market observation analysis was conducted on July 14, 2011 at different markets in Boston, Massachusetts to determine the supply availability of 20 leafy greens that are part of this project (see Table 2.1). Markets were selected based on their importance in supplying leafy greens to ethnic costumers in Boston. This market analysis had the following goals:

- To observe the availability of different types of ethnic leafy greens and their presentations at selected markets.
- To observe the final price that consumers pay for available ethnic leafy greens at selected markets.
- To gather marketing data on how 40 cases of Hierba mora (3.18 kilograms per box and with a wholesale price of $6.60 per Kg would sell at **Compare Super Market** in Chelsea, Massachusetts and **Seabras**, Framingham, Massachusetts during the summer of 2011.

3.3. First attempt at marketing in 2012

The purpose of this initial study was to conduct a preliminary analysis of Red and Yellow purslane to study more about the market potential for these new leafy greens in two Massachusetts markets. Two varieties of organic Purslane, "Gruner red" and "Goldberg golden," were produced in a high tunnel at the UMass Research Farm in Deerfield, MA during the summer of 2012 for this market analysis. The target market for this research was defined as **WNHNE**[1] and non- **WNE**[2] (mostly Latino) potential consumers. Personal interviews were conducted to generate primary descriptive data about the specific characteristics of these leafy green that made them so popular in the

[1] W: White, NH: non-Hispanic, NE: New England Costumers
[2] non-W: non White, NE: New England Costumers

identified communities. To encourage people to take these surveys, samples of both varieties were given to each potential consumer to taste, and information regarding each variety and its potential culinary uses were distributed among the interviewees.

3.3.1. Methodology

Surveys of **WNHNE** and non- **WNE** consumers were used to determine if potential consumers were both willing and able to purchase Purslane and to define which variety of Purslane had the most promising potential to become a popular new leafy green in the Massachusetts produce market. Personal interviews conducted at two selected locations were considered to be the most effective and efficient methods for gathering specific information from the target consumers because: 1) these interviews allowed the interviewer to clarify any confusion that respondents had about certain questions, 2) these interviews accommodated for cultural and linguistic variation among the Latino communities, 3) the bilingual survey (Spanish and English) made it possible for the Latino consumer to choose in which language he or she wanted to take the interview, thus facilitating the social interaction, 4) and lastly, these interviews allowed for interactions with all consumers because after having tasted the exotic leafy greens they were given ideas about potential culinary uses and asked about which variety they preferred based upon the characteristics of the Purslane.

To conduct surveys among the targeted potential consumers, a convenience sample technique was used despite its limitations in this study (e.g., from speaking with only those willing to participate). It was convenient and economical to set up an interviewing station and intercept consumers at the two selected places to take the surveys. The survey instrument at **Amherst Farmers Market** (Survey for **WNHNE**

potential consumers) had only five questions. The survey instrument used at the second place which was **WIC** (Program for Women, Infants and Children) **office** (Survey for non- **WNE** consumers, whom may know Purslane) consisted of 8 questions. Both surveys are described and discussed in the results and discussion section of this chapter.

Additionally, during the surveys potential consumers were asked about price and quantity they would buy of this new leafy green to have an initial estimate of the size for the market of Purslane and also to determine the price that the consumers were willing and able to pay, which allows calculating the wholesale price.

3.3.1.1. Selection of places

This study was conducted at two places, the **Amherst Farmers' Market** and the **WIC Program office** in East Boston. **The Amherst Farmers' Market** was chosen for two main reasons: 1) convenient to UMass and 2) this market's consumer base is largely **WNHNE** consumers who usually buy fresh and locally grown produce (organic & conventional). This consumer base facilitated contact with consumers who may have not been familiar with these vegetables and other kinds of produce but are open-minded to try new vegetable options, such as Purslane.

The survey designed for non- **WNE** consumers was conducted at the **WIC office** in East Boston. The **WIC Program** provides health screenings and nutritional counseling to help mothers and their babies as well as their older children stay healthy. The **WIC Program** also provides financial assistance to help mothers purchase healthy and nutritious food for their children and free lactation services to help mothers who breastfeed their babies. The **WIC office** was chosen as a suitable place to conduct these surveys because: 1) the Latino population has a higher proportion in using WIC services

at this office, and 2) Purslane has nutritional values that adhere to the **WIC Program's** objectives.

3.3.1.2. Consumer survey

In this study, samples of Red and Yellow purslane ("Gruner red" and "Goldberg golden") were used with **WNHNE** consumers as a tool to attract their attention and make them more willing to participate, and also to determine which variety they preferred; with non- **WNE** consumers only Red purslane was used for samples because it is well-known that Latino people prefer the red varieties. At each location, a table was set up with information about the project and with examples of both Red and Yellow purslane. The survey methodology applied at each place consisted of eight steps:

1. Four interviewers were used, two were bilingual (English and Spanish) and two were trilingual (Portuguese, English and Spanish): two were Central American, one was Brazilian and one was Mexican. The four interviewers wore UMass shirts and UMass hats.
2. UMass Extension table cloths identified our table as a UMass sponsored event. Fliers related to Purslane were available on the table as well.
3. Signs were placed on the table indicating that a survey was being conducted. Both crops were being studied for local production at the UMass Research Farm and were available to be used as part of the survey.
4. Also on the table were recipes for others crops of the UMass ethnic Program along with recipes for Purslane.

5. Surveys were conducted on the weekends of June 9, 2012 in Amherst and June 26, 2012 in East Boston. A total of 170 people were surveyed at the two locations: 89 in Amherst, MA and 81 in East Boston, MA.
6. Organic Purslane was available to be sold at each location. At the **Amherst Farmers' Market** Purslane was available to be sold during 5 weeks, however only one time to the East Boston Farmers' market near to the **WIC office.**
7. Data were analyzed by using an analysis of frequency.
8. Results about quality, taste, consumption preferences, and potential culinary uses of the crops and frequency of purchasing were estimated.

3.3.1.3. Sales experiment

At the **Amherst Farmers' Market** both Red and Yellow organic purslane were sold during the experimental period of five weeks. The selection of prices each week was chosen based on price of spinach, a leafy green similar to Purslane which was also available at this market, thus providing an excellent benchmark.

The two varieties of Purslane used in the experiment were produced organically under high tunnel conditions and stored at the Pioneer Valley Growers Association Cooling facility in Whatley, MA. The deliveries of Purslane to farmers' markets were made by UMass personnel to the sales stall of Atlas Farm at the **Amherst Farmers' Market**. Atlas Farm is a diversified 85-acre vegetable farm located in Deerfield, MA that grows certified organic vegetables. The amount of organic Purslane delivered and marketed in the **Amherst Farmers' Market** was 29.1 kilograms equal to 8 boxes containing 3.64 kilograms each, at 27 bunches per box, 0.13 kg per bunch. The details of

Purslane sales through Atlas Farm were: one box on Saturday, June 9, 2012; one box on Saturday, June 16, 2012; two boxes on Saturday, June 23, 2012; two boxes on Saturday, June 30, 2012; and two boxes on Saturday, July 2, 2012.

The prices were changed throughout the experiment in order to gauge consumer purchases at various prices and to determine the most profitable price to the growers for organic product in the long run. Therefore, during the five weeks of commercial presentations of Red and Yellow purslane at the **Amherst Farmers' Market** we recorded how many kilograms were sold at three different prices per bunch. Those prices for the different weeks were: $ 1.50 weeks 1 and 2, $ 2.00 week 3; $ 2.50 weeks 4 and 5. Also, five boxes of Red purslane were sold at East Boston Farmers' market near to the **WIC office** on June 26, 2012**.**

3.4. Expanded attempt at marketing in 2013

The purpose of this expanded study was to conduct a more thorough market analysis to determine the potential demand for a new leafy green. Personal interviews were taken to generate descriptive and quantitative data about marketing's aspects and profitability. Sample of conventional Red purslane were given to each potential consumer who tasted it, and information about the crop and its culinary potential uses were also distributed among the interviewees.

Red purslane was produced during the spring of 2013 under greenhouse conditions at The CNS Research & Education Greenhouses of the University of Massachusetts to be used in market research conducted at **Market Basket** in Chelsea, MA, while Red purslane was produced at the UMass Research Farm in Deerfield, MA during the summer of 2013 for the second part of the research conducted at **Russo's**

Supermarket in Watertown, MA and at the **Waltham Farmers' Market** in Waltham, MA. This expanded test marketing was developed to evaluate the price per pound, presentation, importance, profit level and viability of Red purslane as a new crop in Massachusetts.

3.4.1. Methodology and differences between the first and the expanded attempt at marketing

The same general methodology applied in the first attempt at marketing was applied in the expanded attempt at marketing. The leafy greens surveys were administered in the same way that was done at the **WIC office**. Furthermore, a controlled test marketing was used to evaluate the price sensitivity of the Purslane sold and to measure sales at the different prices in different places.

The major differences between the two attempts at marketing included: other locations were selected for test marketing; two more crops were available to be sold, hierba mora (*Solanum melanocerasum)* and chipilín *(Crotalaria Longirostrata* HOOK. AND ARN*)*, testing for price sensitivity of Red purslane was conducted over the seven weeks, and some modifications were made in the format of survey that are explained in the results and discussion section of this chapter.

3.4.1.1. Selected locations

One of the main differences for this expanded attempt at marketing from the first attempt was the new locations that were selected for the second attempt. These new locations were two stores that are part of an ethnic supermarket chain in the Boston area

and one farmers' market close to the Boston area which offers fresh produce to a diverse immigrant consumer base from around the world.

The first new location was at **Market Basket**, a supermarket in Chelsea, MA that offers some of the most delicious and unique gourmet food products from around the world. The variety of products offered at competitive prices is one of the reasons why **WNHNE** and non- **WNE** consumers alike shop for their groceries at this store. Latino consumers gather to shop, walk and talk, and they agree that this supermarket is one of the best, most well-run and cost-effective grocery stores in the Boston area.

The second location was at **Russo's supermarket** in Watertown, MA, which is a family-run business that began over 75 years ago. This market offers their consumers both quality and diverse produce from around the world. The business is dedicated to delivering only the finest quality fruits and vegetables to their customers, and they also have a strong relationship with local, national and international growers. At **Russo's supermarket**, it is common to find people from diverse ethnic backgrounds both shopping and working at this store.

The third location was at the **Waltham Farmers' Market**, which was established in 1991 by a group of Waltham activists whose main goals include supporting local agriculture, and revitalizing downtown Waltham while also creating a community gathering-place. Shoppers can find fresh Asian, African, and Latino specialty produce among other farm products at the **Waltham Farmers' Market**.

The criteria used to choose those three markets were the following: 1) the size of the produce section in the supermarkets, 2) the retailers willingness to cooperate with the UMass Ethnic Crops Program in marketing research by providing access to their stores

and their produce managers, 3) the possibility for collecting data, and 4) the fact that many **WNHNE** and non- **WNE** consumers purchase their produce at these locations.

3.4.1.2. Consumer survey

The survey methodologies used consisted of the same steps used in the first marketing attempt with some key differences, which were:

1. Two more crops: Hierba mora was planted at the UMass Research Farm and was available only for sale at the **Whaltam Farmers Market** to be tested as part of this research. In addition, Chipilin grown by Pleasant Valley Garden Farm in Methuen, MA was also available for sale as part of the ethnic crop program at UMass.
2. Surveys were conducted at two locations. A total of 146 people were surveyed at the two locations: 48 at **Russo's Supermarket** and 98 at the **Waltham Farmers' Market**. In the supermarket in Chelsea it was not possible to conduct any surveys; nevertheless, some informal interviews took place with people in charge of the produce area and relevant information was obtained on the Purslane sales to understand the market. Also, we were able to talk to some costumers in an informal environment. Kilograms per box were reduced from 3.64 to 3.18 per box and standardized to 25 bunches per box due to a requirement from one of the supermarket.

3.4.1.3. Prince sensitivity

At **Market Basket,** Red purslane produced in the spring of 2013 at CNS UMass greenhouse was offered and sold using different prices per bunch during a period of seven weeks, to evaluate the price sensitivity of the Red purslane and to establish demand

for the crop by measuring quantity of sales at different prices. Additionally, Red purslane produced in the summer of 2013 at the UMass Research Farm in Deerfield, MA was offered and sold at **Russo's Supermarket** and the **Waltham Farmers' Market**. At these two locations fixed retail prices were established at $2.49 per bunch at **Russo's Supermarket** and $1.00 per bunch at **Waltham Farmers' Market**. The purpose of this was to monitor the sales behavior under real market conditions along with the quantity sold per week.

The amount of Red purslane delivered and sold in the three markets was the following: 34 boxes equal to 108.20 kilograms delivered at **Market Basket** in Chelsea but only 32 boxes were sold; 7 boxes delivered and sold at **Russo's Supermarket**, equal to 22.27 kilograms and 4 cases of Purslane equal to 12.73 kilograms sold at the **Waltham Farmers' Market**. The details of Purslane offered and sold through the selected markets are shown in the results and discussion section of this chapter.

3.5. Calculate the marketing bill and profit of selected crops in 2014

The last phase of this marketing assessment was divided into three steps: 1) estimation of an enterprise budget for the promising and selected crops (Yellow and Red purslane and Hierba mora types A and B), 2) calculation of a marketing bill model for Purslane and Hierba mora, and 3) estimate potential profit for yellow and Red purslane and Hierba mora types A and B for growers.

3.5.1. Enterprise Budget

An enterprise budget per crop was created for 2011 and 2012 based on the costs and returns of Red purslane, Yellow purslane and Hierba mora types A and B, and those are discussed in the results and discussion section of this chapter.

3.5.2. Marketing bill

In general, the food marketing bill refers to the market value added to a commodity from all of post-farm activities of the supply chain industries (USDA, 2009). The marketing bill of Red purslane, Yellow purslane and Hierba mora A and B types were created based on farm cost production, packaging, transportation, promotion, wholesale price and retail price. Averages of all of these categories were calculated from data of 2011 and 2012; details on marketing bill are discussed in the results and discussion section of this chapter.

3.5.3. Profit of selected crops

In this step, profit for growers was estimated as a difference between the wholesale prices obtained per Kilogram of and the total production and commercialization cost per pound of Yellow and Red purslane, and Hierba mora types A and B. Also, profit per hectare was estimated for Yellow purslane, Red purslane, and Hierba mora A and B. For this exercise, total cost per hectare and returns for the total production (minus 10% of loss due to perishability of these leafy greens) at wholesale price was calculated from data of 2011 and 2012. For statistical analysis of profit differences among crops, SAS 9.3 (Statistical Analysis System) was used to conduct an annual analysis of variance (F- test) and pair means comparisons among crops by using

Tukey (HSD) test. Profits of selected crops are discussed in the results and discussion section of this chapter.

3.6. Results and discussion

This marketing research discovers and discusses preferences of potential customers, their wiliness to buy these new leafy greens in potential markets, and frequency of purchase, at various prices, potential culinary uses, ethnic background of Purslane and Hierba mora customers, as well as the crops' potential profit for growers.

3.6.1. Marketing field trip and initial sales in 2011

This field trip was organized by the UMass Ethnic Crops Program and implemented in four selected market on July 14, 2011. Four markets were visited taking into consideration four goals that were previously defined. The basic reasoning behind the trip was the fact that Boston urban area has population from different ethnic backgrounds. For instance, the US Census 2010 documented that 51% of the population in East Boston were born mostly in one of the following countries El Salvador, Colombia, Brazil, Mexico, and Italy. Consequently, it was assumed, that these ethnic communities are interested in acquiring fresh leafy greens and herbs attached to their own culture and cuisine. Due to that interest, these potential costumers purchase their produce in markets that are able to offer ethnic produce.

During this marketing field trip, it was learned that the four visited markets offer to their customers some ethnic leafy greens; for example Russo's supermarket had available six leafy greens that were in the list of 20 crops that this research was interested in. Commercials packaging presentation of leafy greens varied from loose Pack choy and

Bok choy to bunches of Dandelion, Radish for leaf, Chinese chives and Fenugreek. However, it is not clear if those markets offer these leafy greens year-round to their customers or only during the growing season in Massachusetts. Nine crops of the 20 crops planted at the UMass farm were found at markets during this field trip. The specifics results are shown in the Table 3.1.

Table 3.1. Field trips results

Selected markets	Leafy greens	Presentation	Price US per unit
Russo's Supper Market	Pak choy	Plastic bag of 0.36 Kg	1.98 per 0.45 Kg
	Baby bak choy	Loose	0.98 to 0.68 Kg
	Pack choy	Loose	0.59 per 0.45 Kg
	Fenugreek/ Methi leaf	Bunch of 0.11 Kg	0.98 per bunch
	Dandelion	Bunch of 0.52 Kg	0.98 per 0.45 Kg
	Pea tendrils	Bunch of 0.30 Kg	1.50
	Radish for leaf	Bunch	0.75 per bunch
	Chinese chives	Bunch of 0.30 Kg	2.49 per 0.45 Kg
Whole Foods	Common Sorrel	Clamshell	2.99 per container
Compare	Pea tendrils	Bunch	1.25
East Boston Farmer	Hierba mora	Bunch	3.00 per 0.45 Kg
Markets	Amaranth	Bunch	2.5 per bunch
	Pak choy	Bag	2.5 per bag

Hierba Mora was promoted in two supermarkets at **Compare** in Chelsea and **Seabras** in Framingham. It was assumed that this crop has many opportunities to be sold at these places due to people with roots or connections in southern Mexico, Guatemala and El Salvador living near to those markets. Some consumers that were interviewed said they would like to have Hierba mora available year- round. In addition, during this market test, consumers expressed a willingness to pay a retail price between $ 19.80 and $ 26.40 per Kg. Hierba mora was sold loose at a wholesale price of $ 13.20 per Kg. However, a more thorough Hierba mora market research is needed in order to understand better this ethnic leafy green.

After this exploratory trip in markets niches, it was concluded that a wide potential opportunities are available for farmers that would like to produce and market ethnic leafy greens and herbs. On the other hand, it is suggested to teach farmers to understand how these market niches behave, the distribution system needed to preserve the quality of these highly perishable produce, to define a pricing strategy, and how to supply the product year round.

3.6.2. First attempt at marketing in 2012

As part of this first attempt at marketing on the introduction of Red and Yellow purslane to market niches in Massachusetts, 170 surveys were conducted with the selected markets in order to evaluate the potential marketability of these exotic leafy greens, before the adoption of these new crops by commercial farmers in the Eastern Seaboard of the US. These surveys were administered at two places, the **Amherst Farmers' Market** and the **WIC Program**.

3.6.2.1. Case of Amherst Farmers' Market

As it has been discussed, 89 surveys were conducted among **WNHNE** potential customers on the weekend of June 9, 2012 in Amherst. Promotion and a sale point for organic Red purslane was arranged in an stand of Atlas Farm at Amherst Farmers' Market, resulting in sale of one box of purslane on Saturday, June 9, 2012; one box on Saturday, June 16, 2012; two boxes on Saturday, June 23, 2012; two boxes on Saturday, June 30, 2012; and two boxes on Saturday, July 2, 2012. The sale exercise was run from 9:00 to 11:30 am, and it was observed that in this period at least 2 boxes of purslane can be sold.

Surveys were conducted with **WNHNE** potential customers to gain an understanding of their interest and willingness to purchase these locally-grown vegetables. Participants tasted organic fresh Red and Yellow purslane, after that they were asked to respond five questions. The first question was: please taste and rank these fresh samples of Red and Yellow purslane, using a scale from 1 to 5. The 5-point, likert-scale evaluation system was used to obtain responses with 1 conveying ‘‘dislike’’ and 5 indicating ‘‘like very much”. Results on taste preferences are shown by Figure 3.1.

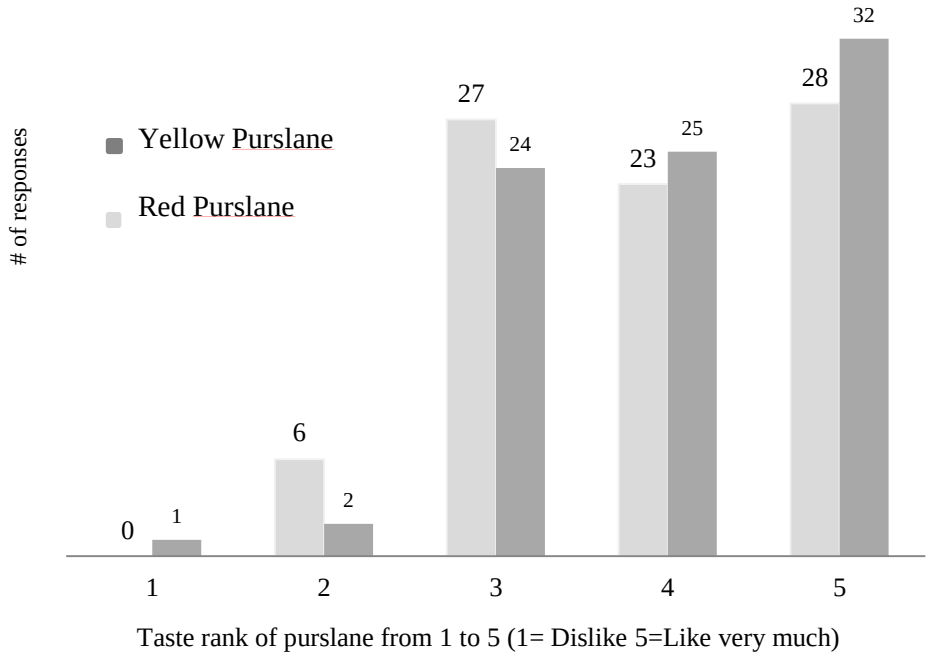

Figure 3.1. Results on taste preferences for Yellow and Red organic Purslane at Amherst Farmers' Market, n= 89.

Based on question one, an analysis of variance was conducted using Statistical Analysis System (SAS) 9.3 program, and there were no statistically significant differences (at P ≥0.05t) costumers preferences between Red and Yellow purslane. But it is clear that 57 costumers (64.04 % of total interviewed costumers) liked Yellow purslane from 4 to 5 categories of preference, and 51 costumers (57.30%) liked Red purslane for the same two categories. Also, 27 costumers (30.34%) responded they liked Red purslane

in category 3, and 24 people (26.97%) liked Yellow purslane in the same category. These findings provided clues on potential commercial opportunities for organic Purslane among **WNHNE** potential customers.

The second question was related to why **WNHNE** potential customers like Purslane? Most of the interviewed consumers said: freshness, tart, good taste, crunchy texture, citrus flavor, little sensation of spicy, texture, and finally some people said that the Red purslane is more bitter than the Yellow purslane. In the third question, potential consumers were questioned if they were going to be at the farmer market next week? A total of 73 **WNHNE** potential customers (82.02%) responded affirmative, 15 said maybe (16.85%), and 1 said no. In the question four, **WNHNE** potential customers where questioned if they would buy Purslane next week, 68 costumers responded affirmative (76.40%), 16 said maybe (17.98%) and 5 responses were negative (5.62%). The last question was, how would costumers use Purslane at home – in what dishes? **WNHNE** potential customers said: salad, sautéed vegetables and soups.

Figure 3.2. Surveying WNHNE potential customers at Amherst Farmer's Market on potential of Purslane as a new leafy green

3.6.2.2. Case of the WIC Program Office

A total of 81 surveys were conducted among non- **WNE** potential consumers on the weekend of June 26, 2012 in East Boston. This exercise had the same purpose of the one conducted at Amherst Farmer's Market. Also, non- **WNE** potential customer tasted organic Red purslane, after that they were asked to respond eight questions. The first question was about gender of the participants. All the interviewed were women, which is understandable because women are the target population of the WIC office. The second question was: Where are you from? Results on this question are shown by Figure 3.3.

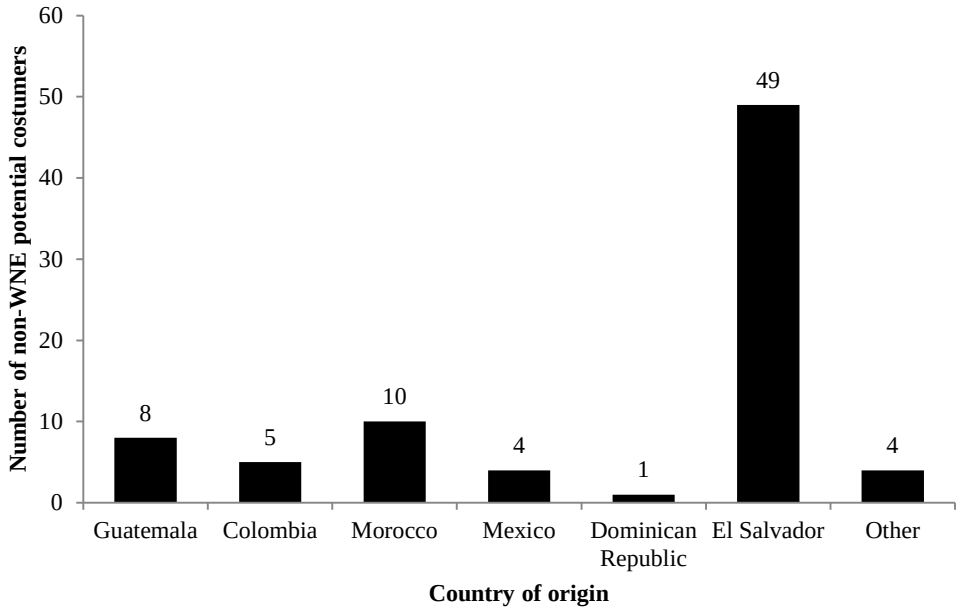

Figure 3.3. Ethnic background of non-WNE potentials costumers of conventional Red purslane, n = 81.

Salvadorians represented 60.49% (49) of **non- WNE** potential costumers surveyed, the second largest ethnic origin was born in Morocco with an 12.35% (10), Guatemalan origin represented 9.88% (8), and other ethnic origins also participated (see Figure 3.6.3)

The third question for **non- WNE** potential customers was: Have you ever eaten Red purslane in your home country? Results revealed that 53.09% (43) of the customers surveyed responded affirmative and 46.91% (38) negative. The fourth question was exclusively for the 43 consumers that responded affirmative and it was: How often do you used to eat Purslane? The results obtained were 51.16 % (22) more than once a week, 20.93 % (9) once per week, 16.28 % (7) twice per month, 9.30 % (4) less than one per month and 2.33% (1) once per month.

The fifth question was: Have you ever eaten Purslane in the USA? A total of 96.30 % (78) of surveyed **non- WNE** potential customers responded negative with only 3.70 % (3) responses haven eaten Purslane in the US.

The sixth question was: Please taste and rank these fresh samples of Red purslane, using an scale from 1 to 5 were 1 conveying ‘‘dislike’’ and 5 indicating ‘‘like very much”. Results on taste preferences are shown by Figure 3.4.

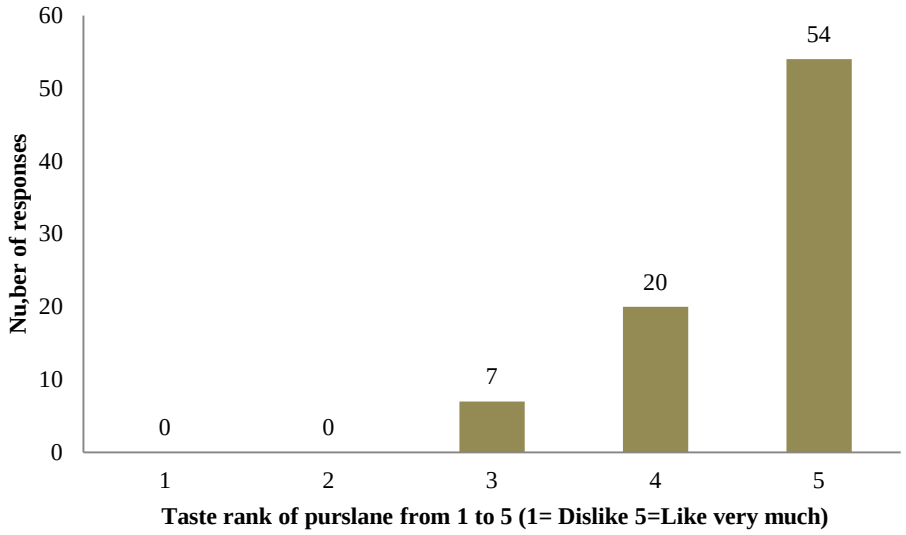

Figure 3.4. Results on taste preferences for Red organic purslane at WIC office. n = 81.

Good acceptance of Red purslane was found, 91.36% (74) **non- WNE** potential costumers liked Purslane from 4 to 5, and only 8.64% (7) ranked Red purslane with 3. The results showed that even consumers that had never seen Purslane before liked this leafy green. Question number seven was: Would you buy Red purslane at a store in your area? In 93.83% (76) of the cases, respondents said they would buy Purslane, 3.70% (3) of the responses were maybe, and 2.47% (2) of the answers were negative.

The last question was, how would costumers use Purslane at home – in what dishes? Most potential costumers said: salad, soups and scrambled eggs. The results, once

again, demonstrated that **non- WNE** potential customers were willing and able to buy Red purslane if this crop were available.

3.6.3. Expanded attempt at marketing in 2013

As it has been previously discussed, this expanded test marketing was developed mostly to evaluate the price per pound, demand, profit level and viability of Red purslane before adoption by commercial farmers as a new crop in Massachusetts.

A total of 146 surveys were conducted at two locations among **WNHNE** and non- **WNE** potential consumers. At the two locations, 48 surveys were taken at **Russo's Supermarket** on January 25, and 98 surveys were conducted at the **Waltham Farmers'** Market, in detail 35 surveys conducted on August 3, 29 surveys on August 10, and 34 surveys on August 17. In Market Basket, it was not possible to conduct any surveys; nevertheless, an exercise to evaluate the price sensitivity of the Red purslane was conducted from January 25 to April 7 to establish demand for the crop by measuring quantity of sales at different retail prices.

3.6.3.1. Case of Russo's Supermarket and Market Basket

Following the same methodology used at the **WIC** office, 48 surveys were conducted at **Russos'**. Also seven boxes of Red purslane were delivered and sold during this exercise, each box of Purslane consisted of 3.18 kilograms[3] with 25 bunches per box, and the retailer price per bunch was $ 2.49. The purpose was to observe the acceptances of Red purslane among **WNHNE** and non- **WNE** potential consumers, and to define

[3] 3.18 Kg per box, 0.13 Kg per each bunch, equal to 25 bunches per box. Russo's' paid a wholesale price of $ 6.60 per Kilogram

potential demand and wholesale and retail price per kilogram of Purslane among other marketing aspects.

The first question was about gender of participants, with 68.75% (33) of women interviewed and 31.25% (15) men. The second question was: Where are you from? Results on this question show that **WNHNE** potential consumers represented 66.67% (32), and all together the **non- WNE** potential costumers surveyed represented 33.33% (16). The largest ethnic origin among **non- WNE** was born in Guatemala with a 14.58 % in overall and 43.75% among **non- WNE** (7 of 16). Results on question two are shown by Figure 3.5. The findings demonstrate that many **WNHNE** potential consumers purchase their produce at **Russo's' Supermarket.**

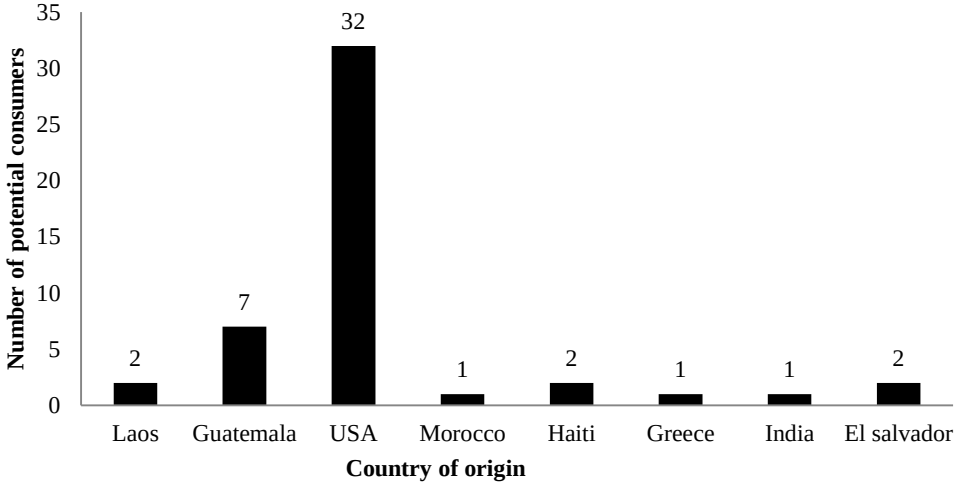

Figure 3.5. Ethnic background of potentials costumers of conventional Red purslane, n = 48.

Because of the important quantity of **WNHNE** potential consumers interviewed**,** a question 2b was asked, that was: What region of the USA are you exactly from? Results of this question are shown in Figure 3.6.

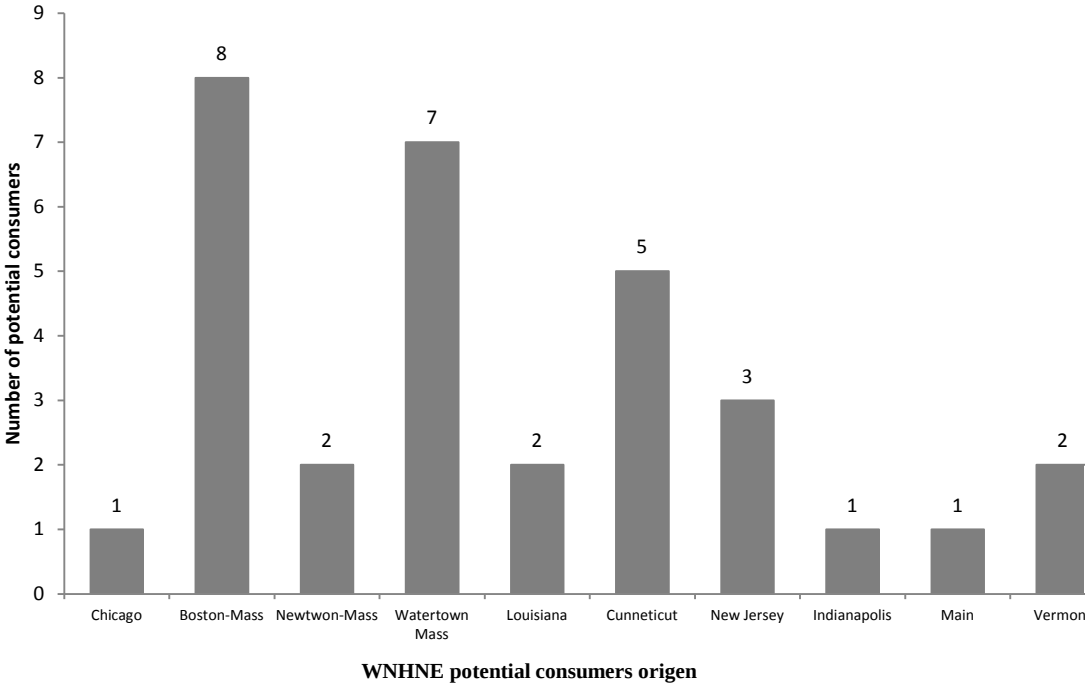

Figure 3.6. Origin of WNHNE potential consumers interviewed at Russo's Supermarket, n = 32.

The three most common origins among of **WNHNE** are 25% (8) from Boston, 21.88% (7) from Watertown, and 15.65% (5) from Connecticut. One issue that limited the **non- WNE** participation in the interviews was the fact that the Farmers Market committee is not able to receive WIC farmers' market coupons, thus Latino costumers were not willing to buy Purslane and take surveys.

The third question for **WNHNE** and non- **WNE** potential customers was: Have you ever eaten Red purslane in your home country? Results revealed that 64.58 % (31) of the customers surveyed responded negative and 35.42 % (17) affirmative. The fourth question was: Have you ever eaten Purslane in the USA? The results revealed that 72.92 % (35) of the customers surveyed responded negative and 27.08 % (13) affirmative. The

fifth question was: Please taste and rank these fresh samples of Red purslane, using a scale from 1 to 5 were 1 conveying ‘‘dislike’’ and 5 indicating ‘‘like very much”. Results on taste preferences are shown by Figure 3.7.

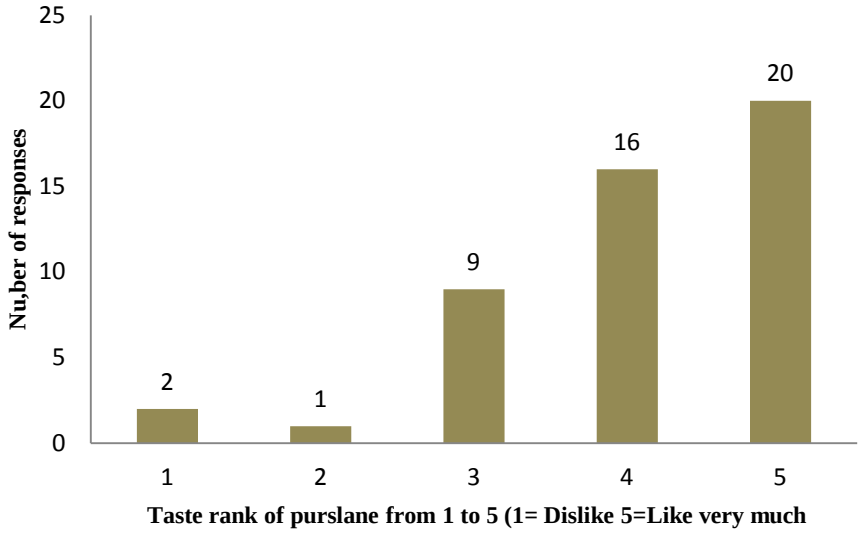

Figure 3.7. Results on taste preferences for Red conventional purslane at Russo’s Supermarket, n = 48.

The acceptance of Red purslane was 75% (36) of potential customers (those rated with 4 or 5), and only 18.7% (9) ranked Red purslane with 3. The results show that 6.25% (3) of potential consumers dislike Purslane, as they ranked it with 1 or a 2. All of consumers that liked Purslane from 3 to 5 (45 potential customers who ranked is taste as 3, 4, or 5) were asked question number six, which was: How often would you eat Purslane? The 20% (9) of the interviewed said more than once a week, 17.77 % (8) responded once a week, 17.77 % (8) said twice per month, 15.56% (7) expressed once per month, and 8.89 % (4) less than one per month. The results suggest that purslane has potential to be purchased by **WNHNE** and non- **WNE** costumers that purchase vegetables at **Russo's Supermarket.**

Related to question number seven, that was: Would you buy Red purslane at a store in your area? In 85.42 % (41) of the cases, respondents said they would buy Purslane and 14.58 % (7) of the responses were negative. The last question was, how would costumers use Purslane at home – in what dishes? The interviewed responses in 75% (36) of the cases were salad, and few potential costumers said fatouche, sea food, scrambled eggs and with tomatoes sauce for beef.

At **Market Basket**, 34 boxes of Purslane, with the same specification than those sold at **Russo's Supermarket** were delivered. At the end of this exercise, 32 cases of Red purslane were sold (102 Kilograms). Different prices per bunch during a period of seven weeks were used, to evaluate the price sensitivity of this leafy green, and to establish the crop demand by measuring quantity of sales at different prices. The results of Purslane testing at **Market Basket** are shown in the Table 3.2.

Table 3.2 Period, quantity and price per bunch of Purslane sold at Market Basket in 2013

Date	Boxes (quantity)		Retail rice
	Delivered	Sold	($/bunch)
01/25/2013	2	2	1.49
01/29/2013	1	1	1.49
02/20/2013	2	2	1.98
02/27/2013	4	4	1.98
03/13/2013	8	8	1.98
04/10/2013	5	5	2.50
04/17/2013	12	10	2.50
Total	**34**	**32**	

This exercise on the price sensitivity of the Red purslane demonstrates that this leafy green was not sensitive to changes of price per bunch through the period of this research. Hence, the discovered retail price can be $ 2.50 per bunch, with a retail price per box of $ 62.50 and a retail price per kilogram of $ 19.65. However, retail prices are

higher than wholesale prices. In this exercise, the wholesale price paid by **Market Basket** was $ 6.31 Kg, equal to $ 0.80 cents per bunch, thus the wholesale price was 68% lower than the retail price. On the other hand, the wholesale price obtained at **Russos' Supermaket** was $6.60 per kilogram, being 66.30% lower than the retail price per kilogram ($ 19.58 per kilogram and $ 2.49 per bunch).

The definition of the wholesale price per bunch is something that can be negotiated with the supermarket in order to obtain a better price and improve profit for farmers. Even though when the prices paid for the supermarkets seem low it has to be analyzed under a profit scenario. Considering only Purslane acceptance by **WNHNE** and non- **WNE** costumers and the wholesale prices received per Kilogram at Russos' Supermarket ($6.60) and at Market Basket ($6.31) it can be concluded that Purslane is a promising crop for adoption by commercial farmers in Massachusetts.

3.6.3.2. Case of Waltham Farmers' Market

A total of 98 surveys were conducted at the Waltham Farmers' Market, 34 interviews were taken in the first lot of surveys conducted on August 3, 2013; in the second lot of surveys 29 interviews were conducted on August 10, 2013 and in the third lot of surveys 34 interviews were conducted on August 17, 2013. Also during these exercises 4 boxes of Red purslane were sold, one on August 3, one on August 10, and two boxes on August 17. Additionally, every Saturday during September 2013 were promoted and sold between two - three boxes of each crop (Red purslane, Hierba mora and Chipilín) starting at 9:30 am and stopping at 1:00 pm.

In this exercise, WNHNE and non- **WNE** potential consumers were interviewed using the same survey utilized at Russo's' Supermarket. The first question in every lot of

surveys was about gender of the participants. In the first lot of surveys, 71.43% (25) women and 28.57% (10) men were interviewed, in the second lot 72.41% (21) women and 27.59% (8) men were interviewed, finally in the third lot 88.24% (30) women and 11.76% (4) men were interviewed.

The second question was: Where are you from? Results on this question show that **WNHNE** potential consumers origin represented in the first lot was 65.71% (23), and all together the **non- WNE** potential costumers surveyed represented 34.29 % (12), in the second lot **WNHNE** potential consumers origin represented 79.31% (23), and **non-WNE** potential costumers surveyed represented 20.69 % (6), and in the third lot **WNHNE** potential consumers origin represented 73.53% (25), and **non- WNE** potential costumers surveyed represented 26.47 (9). The largest **non- WNE** potential costumers surveyed were Guatemalan with 14.29% (5) in lot one, 13,79% (4) in lot two, and 20.59% (7) in lot three. Results and details on costumers surveyed are shown by Figure 3.8.

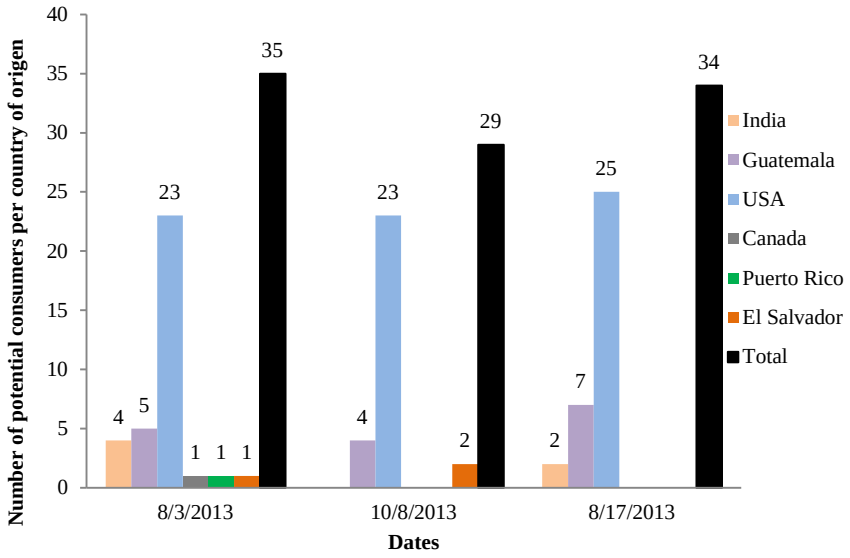

Figure 3.8. Ethnic background of potentials costumers of conventional Red purslane, n = 98.

Because of the important quantity of **WNHNE** potential consumers interviewed**,** a question 2b was asked, that was: What region of the USA are you exactly from? Results of this question revealed that in lot one 52.17% (12) potential customers were from Waltham, Massachusetts, 34,78% (8) from Massachusetts, 8.7% (2) from Connecticut, and 4.35% (1) from Maine. In the second lot, 56.52% (13) potential customers were from Waltham and 43.48% (10) from Massachusetts, and in the third lot 100% (25) costumers were from Waltham.

The third question for **WNHNE and non- WNE** potential costumers was: Have you ever eaten Red purslane in your home country? Results revealed that 71.42 % (25) of the customers responses were negative and 28.57 % (10) affirmative in the first lot, 68.97% (20) responses were negative and 31.03% (9) were affirmative in the second lot, and 64.71% (22) responses were negative and 35.29% (12) responses were affirmative in

the third lot of surveyed customers. Few **WNHNE potentials** customers have tried Purslane before. Between 25% to 35% of the interviewees have a foreign origin.

The fourth question was: Have you ever eaten Purslane in the USA? Results revealed that 88.57% % (31) of the customers responses were negative and 11.43 % (4) affirmative in the first lot, 72.41% (21) responses were negative and 27.59 % (8) were affirmative in the second lot, and 82.35% (28) responses were negative and 17.65 % (6) responses were affirmatively in the third lot of surveyed customers.

The fifth question was: Please taste and rank these fresh samples of Red purslane, using the same scale from 1 to 5 were 1 conveying ‘‘dislike’’ and 5 indicating ‘‘like very much”. Results on taste preferences are shown by Table 3.3.

Table 3.3. Results on taste preferences for Red conventional purslane at Waltham Farmers' market

Please rank the taste from 1 - 5 (1= Dislike 5=Like very much)?	Dates					
	08/03/2013		08/10/2013		08/17/2013	
	Responses	Percentage	Responses	Percentage	Responses	Percentage
1	1	2.86	0	0	0	0
2	2	5.71	0	0	0	0
3	8	22.86	1	3.45	1	2.94
4	10	28.57	10	34.48	12	35.29
5	14	40.00	18	62.07	21	61.76
Total	**35**	**100.00**	**29**	**100.00**	**34**	**100.00**

The acceptance of Red purslane was very good, as 68.57 % (24) of potential customers liked Purslane, judging it from 4 to 5, in the first lot of surveys, 96.55% (28) in the second lot, and 97.05% (33) in the third lot. The results show that **WNHNE and non-WNE** potential customers would welcome Purslane as a new crop to be sold in Waltham Farmers' Market.

For those consumers who liked Purslane, giving it on the taste preference from 3 to 5 (32 potential customers, lot one, 29 from lot two, and 34 from lot three), question number six was asked: How often would you eat Purslane? Details of results are shown by Table 3.4.

Table 3.4. Frequency of potential purchasing for Purslane

	Dates					
	08/03/2013		08/10/2013		08/17/2013	
Responses	Responses	Percentage	Responses	Percentage	Responses	Percentage
1. More than once a week	4	12.5	14	48.28	17	50.00
2. Once per week,	11	34.37	12	41.38	9	26.47
3. Twice per month,	10	31.25	2	6.90	7	20.59
4. Once per Month	5	15.63	1	3.45	1	2.94
5. Less than one per month	2	6.25	0	0	0	0
Total	**32**	**100.00**	**29**	**100.00**	**34**	**100.00**

The results show that Purslane has potential to be purchased by **WNHNE** and non- **WNE** with a frequency that suggests strong interest for purchasing in at least once per week. Also, it was noted that potential customers bought between 1 to 3 bunches of Purslane, with most of the buying 2 bunches of Purslane.

Related to question number seven, that was: Would you buy Red purslane at this farmers' market? In the first lot of surveys 91.43 % (32) of the responses were affirmative, 8.57% (3) were maybe and 2.86% (1) were negative. Additionally, in the second lot of surveys 93.10% (27) of the respondents said they would buy Purslane and 6.90 % (2) of the responses were negative even when they liked Purslane. In the third lot of surveys, responses were 91.18% (31) affirmative, 5.88% (2) were maybe and 2.94% (1) of the responses were negative.

The last question was, how would customers use Purslane at home – in what dishes? The responses were 74.29% (26) salad in lot one, 65.52% (19) in the second lot, and 79.41% (27) in the third lot. Details of results are shown by Table 3.5.

Table 3.5. Potential culinary uses for Purslane

	Dates					
	08/03/2013		08/10/2013		08/17/2013	
Responses	**Responses**	**Percentage**	**Responses**	**Percentage**	**Responses**	**Percentage**
Not buying	1	2.86	2	6.90	1	2.94
Salad	26	74.29	19	65.52	27	79.41
With fish	1	2.86	0	0	0	0
Sautéed squash	1	2.86	2	6.90	0	0
Cream and cheese	1	2.86	0	0	0	0
Scrambled eggs	4	11.43	1	3.45	2	5.88
Sandwich	1	2.86	1	3.45	1	2.94
Juice	0	0	2	6.90	0	0
Soup	0	0	1	3.45	1	2.94
Smoothie	0	0	1	3.45		
With raviolis	0	0	0	0	1	2.94
With beans	0	0	0	0	1	2.94
Total	**35**	**100.00**	**29**	**100.00**	**34**	**100.00**

Purslane is a promising crop to be sold as a new leafy green at Waltham Farmers' Market. Potential **WNHNE** and non- **WNE** consumers found Purslane interesting, and they would be willing to includes it in their regular food choices. They also expressed ideas on the uses for Purslane (see Table 3.5.).

3.6.4. Marketing bill and profit of selected crops

3.6.4.1 Enterprise Budget

The enterprise budget of yellow and Red purslane and Hierba mora types A and B are defined based on production cost, packaging, distribution, promotion and marketing costs of these crops from 2011 and 2012. Detailed enterprise budgets are presented in Appendices C, D, E and F.

3.6.4.2. Marketing bill

Food marketing includes all activities between production and consumption, such as cleaning, packaging, promotion, and distribution. A marketing bill is derived from retail food dollar expenditures minus farm share commodity sales. For Yellow purslane it represents 84.07% (Table 3.6), for Red purslane 84.02% (Table 3.7), for Hierba mora A 78.72% (Table 3.8) and for Hierba mora B 87.17% (Table 3.8). These percentages pay the marketing bill, covering the costs of all activities that lie in the middle between production and final purchases by consumers.

Table 3.6. Estimate of the price of a kilogram of Yellow purslane and marketing bill for 2011 and 2012

Total costs and returns (based on 1 Hectare)	Yellow purslane 2011 (USD)	Yellow purslane 2012 (USD)	Marketing bill (Midrange - Cost)	%
1.Labor costs	47,215.84	46,893.70	47054.77	
2.Machinery costs	3,669.00	3,668.80	3668.9	
3.Material costs	8,916.75	8,916.75	8916.75	
3.1 Farm share	**59,801.59**	**59,479.25**	**59640.42**	**15.93**
4.Packaging cost	7,991.31	7,920.15	7955.73	2.13
5.Marketing cost	20,492.14	19,544.00	20018.07	5.35
6.Promotion cost	1,100.00	1,100.00	1100	0.29
7.Total costs (1+2+3+4+5+6)	89,385.04	$88,043.40	88714.22	
8.Total returns (wholesale price)	120,666.13	119,744.87	120205.5	
9.Net return (8-7) for farmer	**31,281.09**	**31,701.47**	**31491.28**	**8.41**
10. Return for super market - wholesale prices (11-8)	255,100.82	253,153.18	254127	67.89
11.Total return for supermarket (retail price)	**$375,766.95**	**$372,898.05**	**374332.5**	**100**
12. Wholesale price per Kg	6.31	6.31		
13. Cost per Kg (production)	3.13	3.13		
14. Cost per Kg (production and marketing)	4.67	4.64		
15. Profit per Kg for farmer	1.64	1.67		
16. Retail price	19.65	19.65		
17. Kg with quality for market*	19,123	18,977		

* 10% of the harvest was considered waste

Source: enterprise budget and discovered prices from this research (wholesale and retail prices). See Appendix 3.

As with most perishable vegetables crops the amount that goes to paying for production cost is a farm share[4]. In this research, the farm share is 15.93%, with a profit of 8.41%, for Yellow purslane (Table 3.7), 15.98%, with a profit of 8.12%, for Red purslane (Table 3.7), 21.28% with a profit of 20.40% (Table 3.8), for Hierba mora-A, and 12.83% with a profit of 26.38% for, Hierba mora B (Table 3.8).

Table 3.7. Estimate of the price of a kilogram of Red purslane and marketing bill for 2011 and 2012

Total costs and returns (based on 1 Hectare)	Red purslane 2011 (USD)	Red purslane 2012 (USD)	Marketing bill (Midrange - Cost)	%
1.Labor costs	42,769.02	51,184.70	46976.86	
2.Machinery costs	3,656.40	3,679.60	3668	
3.Material costs	8,891.75	8,891.75	8891.75	
3.1 Farm share	**55,317.17**	**63,756.05**	**59536.61**	**15.98**
4.Packaging cost	7,150.13	8,697.02	7923.575	2.13
5.Marketing cost	19,174.92	22,471.96	20823.44	5.59
6.Promotion cost	1,100.00	1,100.00	1100	0.30
7.Total costs (1+2+3+4+5+6)	82,742.22	96,025.03	89383.625	
8.Total returns (wholesale price)	107,964.10	131,330.03	119647.065	
9.Net return (8-7) for farmer	**25,221.88**	**35,305.00**	**30263.44**	**8.12**
10. Return for super market - wholesale prices (11-8)	228,247.40	277,645.42	252946.41	67.89
11.Total return for supermarket (retail price)	**336,211.50**	**408,975.45**	**372593.475**	**100.00**
12. Wholesale price per Kg	6.31	6.31	6.31	
13. Cost per Kg (production)	3.23	3.06	3.145	
14. Cost per Kg (production and marketing)	4.84	4.61	4.725	
15. Profit per Kg for farmer	1.47	1.7	1.585	
16. Retail price	19.65	19.65	19.65	
17. Kg with quality for market*	17,110	20,813	18961.5	

*10% of the harvest was considered waste

Source: enterprise budget and discovered prices from this research (wholesale and retail prices). See Appendix 4.

Wholesale prices, retail prices, costs per kilogram by activity, and profit per kilogram are given the respective marketing bill tables for these crops (see Tables 3.6, 3.7 and 3.8.). Estimating the real costs obtained in this study show that it is profitable for growers to produce and market these crops. However, it depends on the farmers, wholesaler interests, and the economic market to determine final profitability for any one

[4] The farm share does not include packaging and promotion cost.

venture. In conclusion, although the discovered prices in this research are profitable, growers must analyze their marketing options, as other options may exist that provide even greater profits or lower risks.

Table 3.8. Estimate of the price of a kilogram of Hierba mora A and marketing bill for 2011 and 2012.

Total costs and returns (based on 1 Hectare)	Hierba Mora A 2011	Hierba Mora A 2012	Marketing bill (Midrange - Cost)	%	Hierba Mora B 2011	%
1.Labor costs	18,855.34	15,766.24	17310.79		41,222.44	
2.Machinery costs	3,618.80	3,610.80	3614.8		3,756.80	
3.Material costs	10,805.50	10,805.50	10805.5		10,805.50	
3.1 Farm share	**33,279.64**	**30,182.54**	**31731.09**	**21.28**	**55,784.74**	**12.83**
4.Packaging cost	5,306.70	4,135.85	4721.275	3.17	13,761.84	3.17
5.Marketing cost	10,813.70	9,628.12	10220.91	6.85	32,039.90	7.37
6.Promotion cost	1,100.00	1,100.00	1100	0.74	1,100.00	0.25
7.Total costs (1+2+3+4+5+6)	50,500.04	45,046.51	47773.275		102,686.48	
8.Total returns (wholesale price)	83,806.80	72,593.40	78200.1		217,331.40	
9.Net return (8-7) for farmer	**33,306.76**	**27,546.89**	**30426.825**	**20.40**	**114,644.92**	**26.38**
10. Return for super market - wholesale prices (11-8)	83,806.80	58,073.40	70940.1	47.57	217,331.40	50.00
11.Total return for supermarket (retail price)	**167,613.60**	**130,666.80**	**149140.2**	**100**	**434,662.80**	**100.00**
12. Wholesale price per Kg	6.6	6.6	6.6		6.6	
13. Cost per Kg (production)	2.62	3.05	2.835		1.7	
14. Cost per Kg (production and marketing)	3.98	4.55	4.265		3.12	
15. Profit per Kg for farmer	2.62	2.78	2.7		3.48	
16. Retail price	13.2	13.2	13.2		13.2	
17. Kg with quality for market *	12,698	9,899	11298.5		32,929	

*10% of the harvest was considered waste

3.6.4.3. Fresh weight and profit for selected crops

Fresh weight and profit for each of the four main crops were examined through an analysis of variance, the ANOVA results (Table 3.9) showed highly statistical significant differences on these two dependent variables in 2011 (at P<.0001), and there were statistical significant differences for fresh weight (at P = 0.0020) and non-significant statistical differences for profit in 2012 (see Table 3.9). Means pairs comparisons were

conducted by Tukey (HDS, honest significant difference) using the SAS statistical package. In 2011, differences between pair comparison of profit per hectare greater than $ 22,418.00 were statistically significant; as a result, Hierba mora B had the highest profit per hectare; Crops marked with the same letter after the number in the Table 3.9, such as Yellow purslane, Red purslane and Hierba mora A had any significant statistical difference in profit per hectare. For fresh weight means pair comparison, differences greater than 8,146 Kilograms per hectare were statically significant (at $P \leq 0.05$). Hierba mora B also had the highest fresh weight among the four crops through mean pair comparison; there were not any significant statistical differences for fresh weight of Yellow purslane, Red Purslane and Hierba Mora A. In 2012, there were statistical significant differences for fresh weight; differences greater than 6,204 Kilograms between pairs comparison between crops were significant (at $P \leq 0.05$); there were not any significant statistical differences in profit per hectare among crops. The complete results for the significance of means comparison among crops for the two dependent variables are in Table 3.9.

Table 3.9. Analysis of variance and mean pair comparison for fresh and profit per hectare for Yellow and Red purslane and Hierba mora types A and B grown at the UMass Research Farm in Deerfield MA in 2011 and 2012.

	2011		2012	
Common name of crop	Fresh weight ($kg \cdot ha^{-1}$)	Profit/ Hectare	Fresh weight ($kg \cdot ha^{-1}$)	Profit/ Hectare
Yellow Purslane	19,123 b	31,282.09 b	18,977 a	31,701.47 a
Red Purslane	17,110 b	25,221.88 b	20,813 a	35,305.00 a
Hierba mora-A	12,698 b	33,306.76 b	9,899.00 b	27,546.89 a
Hierba mora -B	32,929 a	114,644.92 a	NA	NA
Significance	<.0001 **	<.0001 **	0.0020 *	0.2225 NS
HSD	8,146	22,418	6,204	13,485

NS,*,**

HSD significant at $P \leq 0.05$.

Means with the same letter are not statistical different through pair mean comparison

10% of the fresh weight harvested was considered as waste in both years

In 2011, the highest level of production was obtained by Hierba mora-B and at the same time had the highest level of profitability with $114,645 per hectare. For Yellow and Red purslane and Hierba mora A, there were not statistical significant differences for pair comparison for fresh weight and profit (at $P \leq 0.05$). In 2012, the Yellow and Red purslane obtained the highest level of production; however, there were not statistical significant differences between pair comparison, but significant statistical differences between pair comparison of the two types of Purslane with Hierba mora A were found. Related to profitability, no statistical significant differences between pair comparison for the three crops were found.

The statistical analysis shows that Hierba mora type B is the most profitable crop. At the same time there are no statistical significant differences on profitability for Yellow purslane, Red purslane and Hierba mora A, in both years.

Although all four crops proved profitable in this study, only one was statistically significantly more profitable than the others. However, growers should not take these results to mean they should specialize in only growing and marketing Hierba mora-B. They not should lower their risk by growing both Purslane and Hierba mora in their introductory season. Only after a season or two will they have a better idea if specialization is warranted.

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CHAPTER 4

CONCLUSIONS

4.1. Production trials

Leafy green yields were discussed because they provide the greatest insight into the cultivars' performance. In 2011, the six most promising top-yielding leafy greens with potential for markets in the Northeastern US were Hierba mora-B, Dandelion, Indian sorrel, Yellow purslane, Red purslane and Amaranth. These crops had between 40,825 to 15,820 $kg \cdot ha^{-1}$ in fresh weight yield. In 2012, the six most promising top-yielding leafy greens with potential for marketing were Red Purslane, Yellow purslane, Pak choy, Quincy choy, Lettuce lolo and Dandelion. Fresh weight was from 21,086 to 13, 482 $kg \cdot ha^{-1}$. In 2012, Green zobo and Radish had higher fresh weight than Pak choy, Quincy choy, Lettuce lolo and Dandelion; however, no marketing potential for these crops was identified.

Farmers interested in the production of the identified promising crops need to understand and apply sound agricultural practices to reach appropriated levels of production and also to understand how market niches work.

Most of the leafy greens that were part of this research can be harvested multiple times by cutting them an average of 10 to 15 centimeters from ground, allowing them to have enough laterals shoots to regrow. Lettuce lolo, Lettuce tropicana, Quincy choy and Pack choy only can be harvested one time. Sugar pea and Fenugreek were cut multiple times, but the regrowth was very poor. One possibility for harvesting these two crops is to harvest them with the root system approximately 30 days after transplant, which also will help to keep freshness and leafy green quality. In fact, Fenugreek, also called Methy

leaf, was found in Russo's Supermarket at Watertown Massachusetts in bunches with roots intact. For Based on this research, it is recommended to harvest Yellow and Red purslane without the root systems which allows these crops to have multiple harvests resulting in higher yields. However, in Mexico and Central American, where Purslane is popular, they are harvested with the root system intact.

Radish, Green zobo, Red zobo and Pápalo may be produced in the USA for leafy greens; however, potential demand and markets have to be identified before starting commercial field production. Additionally, further field research may be required to fully understand the growing behavior and identifying sound agricultural practices.

Leafy greens such as Quincy choy, Pack choy, Lettuce lolo, Lettuce tropicana, Garlic chives and Garlic for greens can be produced in the USA and they already have an established market. All of them were found in different markets in Boston, Massachusetts, and some commercial farmers in Massachusetts produce these crops. Sugar pea for pods has a very strong established market, and it is also produced by commercial farmers in Massachusetts.

Leafy greens that were observed field limitations for field production in Massachusetts were Fenugreek, Sugar pea, and Epazote. Fenugreek and Sugar pea were susceptible to insect damage and Epazote is a crop that produced poor quality foliage. On the other hand, Magenta spreen grew well, but it is not the variety that potential consumers want to buy.

For choosing crops from the identified promising crops, three criteria were considered, which are:

1. Potential market demand,

2. Latino and American customers' interest in buying,

3. Adaptability under Massachusetts field conditions for production and fresh yield performance.

Based on these criteria, Red purslane, Yellow purslane, Hierba mora-A and Hierba mora-B were selected to conduct a marketing assessment to determine marketing and profit potentials. However, before adoption of these crops by commercial farmers, it is necessary to conduct future research to address disease issues in Purslane production and secure the best seed sources for Hierba mora production.

4.2. Marketing assessment

In this research on ethnic market niches, it is concluded that there are potential opportunities for farmers who want to produce and commercialize leafy greens for these markets. However, farmers need to understand how these market niches behave, assess the adequaty of the distribution system to preserve the quality of these highly perishable produce, define a pricing strategy, identify customers preferences, use appropriate presentations, and mantain supply year round.

Hierba Mora has many opportunities to be produced in Massachusetts and commercialized in market niches were people with roots in Southern Mexico, Guatemala and El Salvador make their purchases. A wholesale price discovered for this leafy green was $ 13.20 per Kg ($6.00 per pound); however, consumers want to have Hierba mora year- round. In adition, the retail price was between $19.80 and $26.40/kg ($ 9.00 to $ 12.00 per pound). Hierba Mora was sold at a whole sale price of $13.20/Kg. Further market research is needed in order to better understand this ethnic leafy green and to determine the wholesale price.

At a farmers' market in Amherst MA, a total of 89 **WNHNE** potential customers participated in this research; nosignificant statistically differences on customers preferences among Yellow and Red purslane were found. Ninety-five percent of the customers liked the Yellow purslane and 91% liked the Red purslane according to the scale that was used. Consumers seemed to enjoy the freshness, the taste, and the texture of boths types of purslane; 76% of the customers said they would buy purslane, 18% said maybe and 6% said they would not. Based on these findings, farmers who want to produce purslane to sell in this market can produce either Red or Yellow purslane without concerns on crop preferences.

In the WIC office located at East Boston, there were conducted 81 surveys among non **-WNE** potential consumers; findings revealed that 53% of the customers were familiar with Red purslane while 47% did not known this leafy green. Customer acceptance was 91.36% for Red purslane (ranked a 4 or a 5 using a 5 point scale), and even consumers who did not know purslane liked this leafy green. Related to the willingness to purchase Red purslane, 93.83% would would buy purslane every week or every two weeks.

The target pontential costumers of the exercise conducted at Russo's Supermarket were **WNHNE** and non-**WNE** where a total of 48 customers were interviewed on Red purslane. The **WNHNE** background origin represented 67%, and non-**WNE** were 33%, mostly from Guatemala. Customers who had consumed purslane were 35% and 65% had not consumed purslane before this event. The acceptance of Red purslane was high, with 75% of customers liked purslane (ranked a 4 or a 5 using a 5 point scale), and 85% of the customers would buy purslane in the future; 15% of the customers will not buy purslane

if the crop were available at this market. There is a potential to promote purslane mostly among **WNHNE** consumers, but information on culinary uses and health properties of this crop is needed to increase sales.

At the Waltham Farmers' Market, a total of 98 surveys were conducted among potential customers, 72% with **WNHNE** and 28% with non-**WNE**, mostly from Guatemala. Red purslane was identified as a leafy green by 32% of those interwieved and 68% had not known of purslane before. A total of 87% of potential consumers liked purslane (ranked a 4 or a 5 using a 5 point scale), and 92% of those interwieved would buy purslane if it were available at this market. There was strong interest among **WNHNE** to include purslane in their purchases because it is an interesting source for salad with nutritious properties, texture, lemony flavor and fresh quality. Also non-**WNE** were willing to buy purslane from farmers who accepted WIC cupons.

This study was conducted in three farmers' market (Amherst, Waltham and East Boston), and it was found that **WNHNE** and non-**WNE** potential costumers were willing to pay a retail price from $1.00 to $2.50 per bunch (three bunches = one pound). Hence, farmers have to consider the implications and costs to sell purslane at this type of market to define a price with acceptable profit. When the price was increased at the Amherst Farmers' Market, potential customers purchased almost the same quantity, suggesting that crop sales were not sensitive to price increases and thus could be sold at the higher prices.

In this marketing assessment for Purslane, a price sensitivity excersice was conducted in a supermarket during seven weeks. Costumers were not sensitive to changes of price per bunch throughout this study. Hence, the discovered retail price of $2.50 per

bunch, with a retail price per box of $62.50 and a retail price per kilogram of $19.65 ($8.93 per pound). In this exercise, the wholesale price paid by the supermarket was $6.31 Kg ($ 2.87 per pound), equal to $ 0.80 cents per bunch. Based on this experience, farmers may negotiate the wholesale price with a supermarket store considering its production cost and price strategies they have selected. This discovered price can be the benchmarking for negotiation.

In general, in both years, the statistical highest level of profit was obtained by Hierba mora-B, mostly because of its abundant foliage production and lower labor for harvesting. In 2011, Yellow and Red purslane and Hierba mora-A had no statistical significant differences on profitability. Again in 2012, there were found no statistical significant differences on profitability of Yellow purslane, Red purslane and Hierba mora-A. In both years, Yellow purslane had an average farm share of 15.93% with a profit of 8.41%; Red purslane had an average farm share of 15.98%, with a profit of 8.12%; Hierba mora-A had an average farm share of 21.28% with a profit of 20.40%. In 2011, Hierba mora-B had a farm share of 12.83% with a profit of 26.38%. In this scenario, real costs obtained in this study show that it is profitable for farmers and markets to produce and commercialize these four promising new leafy greens in Massachusetts; however, farmers and wholesaler need to analize their profit interests and risks.

As to quantities sold, based on this reseach it is estmiated that in retail markets studied in this work, **Market Basket** and **Russos's Supermarket**, 10 boxes (32 kg or 70 pounds) perweek, and in the farmers' markets studied in this work, in Amherst and Waltham, between 3 to 4 boxes can be sold per week. And since we found these

quantities were no sensitive to retail price between $1.00 and $ 2.50 per bunch should be priced at $2.50. Thus, growers should negociate for a higher farm price.

APPENDIX A

PURSLANE DISEASE REPORT 2012

DIAGNOSTIC REPORT
Sample# 201201032
Field ID **2012-1021**
Host **Common Purslane**
Received Date **9/14/2012**
County **Middlesex**
State **MA**

Diagnosis and Recommendation:

Host/Habitat: Common Purslane (*Portulaca oleracea*)
List of Diagnosis/ID(s): Rhizoctonia Crown and Stem Rot (Thanatephorus (Rhizoctonia) cucumeris (solani))

Final Report

Specimen received was infected by *Rhizoctonia* root rot and stem canker caused by strains of the soil-borne fungus *Rhizoctonia solani*. This pathogen is common throughout the world. The pathogen survives between crop seasons as sclerotia (survival structures) or mycelium in the soil or on or in infected plant debris. It is spread in infested soil or plant debris by wind, rain, irrigation water, and machinery. When a soil becomes infested, it remains so indefinitely. Seedlings and young plants are highly susceptible to infection and disease severity is increased by low soil temperatures and soil compaction. Seed decay and damping off can be controlled by using high quality seed, with high germination and vigor, by treating seed with recommended fungicides (thiram, captan, mefenoxam, or PCNB), and by practices that encourage rapid germination and emergence. Seed treatments are not effective against infections later in the season. The disease may be reduced by sowing seed as shallowly as possible in warm, moist soil. Land preparation that minimizes soil compaction and structural damage will lessen disease severity. Rotate crops with a cereal or pasture crop (avoid beets, beans, Brassicas and potatoes which increase inoculum). Cover crops and other practices that to increase organic matter and improve soil structure are recommended. Some brassica crops (mustard, rape) used as green manure have been reported to be disease suppressive. Avoid incorporating green manure immediately before planting and damaging roots by shallow cultivation. Fungicides can manage *Rhizoctonia* root rot on young seedlings if applied as a seed treatment or soil drench (Terrachlor, PCNB, thiophantemethyl), but are largely ineffective on established crops.

UMass Extension Plant Diagnostic Clinic
101 University Drive
Slobody Building Suite A7
Amherst MA 01002
Telephone : (413)545-3209 Fax : (413)545-4385

Diagnosed By :
M.Bess Dicklow (mbdicklo@umext.umass.edu)
Completed Date: 9/14/2012

No product endorsement is implied by recommendations. Always follow the label if there is disagreement with these recommendations.

APPENDIX B
PURSLANE DISEASE REPORT 2013

DIAGNOSTIC REPORT
Sample# 201300609
Field ID 2013-589
Host Common Purslane
Received Date 7/22/2013
County Hampshire
State MA

Diagnosis and Recommendation:

Host/Habitat: Common Purslane (*Portulaca oleracea*)
List of Diagnosis/ID(s): Leaf Speckle (Drechslera portulacae), Poor Root Development (Abiotic disorder)

Final Report

Root growth on the specimen received seemed to be extremely limited for a plant of its size. *Drechslera portulacae* leaf spot was detected. *Drechslera* leaf spot is a disease ofmany horticultural, woody, and agricultural plants. Optimum conditions for disease development include long periods of 90-100% relative humidity with nighttime leaf-wetting and daytime drying. High levels of disease may arise from only a few infected plants, since each lesion produces large numbers of conidia. Dissemination of conidia is primarily by water, although wind, insects, and workers can also spread the pathogen. The fungus overwinters in infected crop residues or in weed hosts and is very host specific. Management: Remove and destroy affected plants and infected plant debris. Improve air circulation and light penetration by plant spacing and weed removal. Reduce leaf wetness duration by watering in the morning, reducing plant canopy density, and directing water to the base of plants. Applications of protectant fungicides will slow disease spread. Endura, Fontelis, Quadris, Cabrio, and Switch are registered for various leaf spots on the leafy vegetables group.

UMass Extension Plant Diagnostic Clinic
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Amherst MA 01002
Telephone : (413)545-3209 Fax : (413)545-4385

Diagnosed By :
M.Bess Dicklow (mbdicklo@umext.umass.edu)
Completed Date: 7/23/2013

No product endorsement is implied by recommendations. Always follow the label if there is disagreement with these recommendations.

APPENDIX C

ENTERPRISE BUDGET WITH VARIABLE COSTS FOR YELLOW PURSLANE 2011 AND 2012

Enterprise budget for purslane[1] -*Portulaca oleracea*	Yellow purslane 2011		Yellow purslane 2012	
Activities	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)
Take soil tests	3.00	-	3.00	-
Plow and disk	9.88	9.88	9.88	9.88
Apply compost[2]	24.70	24.70	24.70	24.70
Lay plastic and drip	12.35	9.88	12.35	9.88
Transplant red purslane[3]	72.72	19.76	72.72	19.76
Set up drip system	14.82	14.82	14.82	14.82
Cultivate weeds[4]	59.28	49.40	59.28	49.40
Water and fertigate	98.80	-	98.80	-
Scout for pests	15.00	-	15.00	-
Harvest and pack[5]	3,007.00	-	2,984.00	-
Internal product transportation (labor and machinery)[6]	6.01	6.01	6.00	6.00
Prepare soil and plant cover crop[7]	49.00	49.00	49.00	49.00
Total hours	3,372.56	183.45	3,349.55	183.44
Total labor costs	$47,215.84	$3,669.00	$46,893.70	$3,668.80
Materials (based on 1 hectare)				
Soil tests (2 basic and 4 nitrate tests)	$70.00		$70.00	
Compost	$1,976.00		$1,976.00	
Black plastic mulch and drip[8]	$645.50		$645.50	
Seed[9]	$31.25		$31.25	
Transplants[10]	$5,700.00		$5,700.00	
Fertilizer through drip[11]	$494.00		$494.00	
	$8,916.75		$8,916.75	
Packaging cost				
Boxes[12]	$ 7,215.60		$ 7,150.40	
Plastic bags[13]	$ 144.31		$ 143.21	
Rubber band[14]	$30.10		$29.84	
Labels[15]	601.30		$596.70	
	$7,991.31		$7,920.15	
Marketing cost				
Delivery to PVGA[16]	$204.34		$204.00	
Marketing delivery (commission) [17]	$20,287.80		$19,340.00	
	$20,492,14		$19,544.00	
Promotion cost				
Recipes[18]	$500.00		$500.00	
Commercials or radio[19]	$600.00		$600.00	
	$1,100.00		$1,100.00	
Total costs and returns (based on 1 Hectare)				
Labor costs	$47,215.84		$46,893.70	
Machinery costs	$3,669.00		$3,668.80	
Material costs	$8,916.75		$8,916.75	
Packaging cost	$7,991.31		$7,920.15	
Marketing cost	$20,492,14		$19,544.00	
Promotion cost	$1,100.00		$1,100.00	
Total costs	$89,385.04		$88,043.40	
Total returns[20] (	$120,666.13		$119,744.87	
Net for farmer (Total returns – Total costs)	$31,281.09		$31,701.47	
Total returns for supermarket[21]	$375,766.95		$372,898.05	

[1] Labor costs based on 1 hectare, 30,520 plants per hectare. For this calculation were used 2 cuttings in 2011 and 3 cutting in 2012.

[2] Based on soil test results – no lime needed. Applied 4.94 tons/ Hectare of compost @ $400/ton

[3] Included: popping plants from trays is equal to 17.29 hours putting plants into holes from the planting machine done by three people is equal to 4.94 hours per person (total 12.20 hours) and planting plants on the ground is equal to 43.23 hours. Total time: **72.72 hours.**

[4] Combination of tractor, rototiller and by hand

[5] Yellow Purslane (2011): based on 21,248 Kg/hectare (10% waste equal to 2,125 kg); 19,123/ 3.18 Kg per box =6,013 boxes, 25 bunches per box, 0.13 Kg per bunch; 2 boxes/person/hour = **3,007** hours of labor. Yellow Purslane (2012): based on 21,086 Kg /hectare (10% waste equal to 2,109 Kg); 18,977 Kg/ 3.18 Kg per box =5,967 boxes, 25 bunches per box, 0.13 Kg per bunch; 2 boxes/person/hour = **2,984** hours of labor

[6] Internal transportation to move produce from field to packing facility, 1000 boxes per hour, equal to 6.01 hours in 2011 and 6.00 hours in 2012.

[7] Includes removing plastic

[8] $370.5 for drip; $75 for header; $200 for 1 mil black embossed = $645.50

[9] Based on 30,520.00 plants/Hectare for red purslane (black plastic 1.83 meters on center with 2 rows and 30 centimeters within rows), price of one ounce = $31.25: http://www.johnnyseeds.com/p-5822-goldberg-golden-purslane.aspx

[10] 475 72's cell trays = 32,520 plants (plus 5% extra plants); $12x 475 = $5,700.00, for both red and yellow purslane.

[11] Estimated for soluble fertilizer – exact amounts will depend on nitrate and soil tests

[12] Yellow purslane (2011): 6,013 boxes X $1.20box = $ 7,215.60. Yellow purslane (2012): 5,967 boxes X 1.20 box = $ 7,150.40

[13] In 2011 6,013 bags and 5,967 bags in 2012 ($ 0.024 per bag): http://www.interplas.com/gusseted-poly-bags/3-mil-gusset-on-roll-plastic-bags

[14] 1000 rubber band: $ 5.00.

[15] In 2011 6,013 labels and 5,967 labels in 2012 ($ 0.10 per label).

[16] 1000 boxes per hour of transportation ($20 per hour) and hour of labor ($14 per hour). 2011 equal to 6.01 hours X 20 + 6.01 X 14= $ 204.34. In 2012 6 hours X 20 + 6 X 14= $ 204

[17] PVGA (17%) from gross income.

[18] 1000 per week, keeping during 10 weeks (10,000 recipes, price 0.05).

[19] Cost per week $60 (10 weeks).

[20] 2011: 19,123 Kg X $ 6.31= $120,666.13; 2012: 18,977 Kg X $ 6.31 = $ 119,744.87 (wholesale price $ 6.31 per Kg)

[21] 19,123 Kg X $ 19.65 = $375,766.95; 2012: 18,977 Kg X $ 19.65 = $ 372,898.05 (retail price $ 19.65 per Kg).

APPENDIX D

ENTERPRISE BUDGET WITH VARIABLE COSTS FOR RED PURSLANE 2011 AND 2012

Enterprise budget for purslane[1] -*Portulaca oleracea*	Red Purslane 2011		Red Purslane 2012	
Activities (1 hectare)	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)
Take soil tests	3.00	-	3.00	-
Plow and disk	9.88	9.88	9.88	9.88
Apply compost[2]	24.70	24.70	24.70	24.70
Lay plastic and drip	12.35	9.88	12.35	9.88
Transplant red purslane[3]	72.72	19.76	72.72	19.76
Set up drip system	14.82	14.82	14.82	14.82
Cultivate weeds[4]	59.28	49.40	59.28	49.40
Water and fertigate	98.80	-	98.80	-
Scout for pests	15	-	15.00	-
Harvest and pack[5]	2,690.00	-	3,272.00	-
Internal product transportation (labor and machinery)[6]	5.38	5.38	6.54	6.54
Prepare soil and plant cover crop[7]	49.00	49.00	49.00	49.00
Total hours	3,054.93	182.82	3,638.09	183.98
Total labor costs	$42,769.02	$3,656.40	$51,184.70	$3,679.60
Materials (based on 1 hectare)				
Soil tests (2 basic and 4 nitrate tests)	$70.00		$70.00	
Compost	$1,976.00		$1,976.00	
Black plastic mulch and drip[8]	$645.50		$645.50	
Seed[9]	$6.75		$6.75	
Transplants[10]	$5,700.00		$5,700.00	
Fertilizer through drip[11]	$494.00		$494.00	
	$8,891.75		$8,891.75	
Packaging cost				
Boxes[12]	$6,456.00		$7,852.80	
Plastic bags[13]	$129.13		$157.10	
Rubber band[14]	$27.00		$32.72	
Labels[15]	$538.00		$654.40	
	$7,150.13		$8,697.02	
Marketing costs				
Delivery to PVGA[16]	$182.92		$222.36	
Marketing delivery[17]	$18,992.00		$22,249.60	
	$19,174.92		$22,471.96	
Promotion cost				
Recipes[18]	$500.00		$500.00	
Commercials or radio[19]	$600.00		$600.00	
	$1,100.00		$1,100.00	
Total costs and returns (based on 1 Hectare)				
Labor costs	$42,769.02		$51,184.70	
Machinery costs	$3,656.40		$3,679.60	
Material costs	$8,891.75		$8,891.75	
Packaging costs	$7,150.13		$8,697.02	
Marketing costs	$19,174.92		$22,471.96	
Promotion costs	$1,100.00		$1,100.00	
Total costs	$82,742.22		$96,025.03	
Total returns[20]	$107,964.10		$131,330.03	
Net (Total returns – Total costs)	$25.221.88		$35,305.00	
Total returns for supermarket[21]	$336,211.50		$408,975.45	

[1] Labor costs based on 1 hectare, 30,520 plants per hectare. For this calculation were used 2 cuttings in 2011 and 3 cutting in 2012.

[2] Based on soil test results – no lime needed. Applied 4.94 tons/ Hectare of compost @ $400/ton

[3] Included: popping plants from trays is equal to 17.29 hours putting plants into holes from the planting machine done by three people is equal to 4.94 hours per person (total 12.20 hours) and planting plants on the ground is equal to 43.23 hours. Total time: **72.72 hours.**

[4] Combination of tractor, rototiller and by hand

[5] Red Purslane (2011): based on 19,011Kg /hectare (10% waste equal to 1,901 kg); 17,110/ 3.18 Kg per box =5380 boxes, 25 bunches per box, 0.13 Kg per bunch; 2 boxes/person/hour = **2690** hours of labor. Red Purslane (2012): based on 23,125 Kg /hectare (10% waste equal to 2,312 Kg); 20,813 Kg/ 3.18 Kg per box =6,544 boxes, 25 bunches per box, 0.13 Kg per bunch; 2 boxes/person/hour = **3,272** hours of labor.

[6] Internal transportation to move produce from field to packing facility, 1000 boxes per hour, equal to 5.38 hours in 2011 and 6.54 hours in 2012.

[7] Includes removing plastic.

[8] $370.5 for drip; $75 for header; $200 for 1 mil black embossed = $645.50

[9] Based on 30,520.00 plants/Hectare for red purslane (black plastic 1.83 meters on center with 2 rows and 30 centimeters within rows) which is 1 ounce. = $6.75 (based on 65,000 seeds/ounce source from Johnny's Selected Seeds): http://www.johnnyseeds.com/p-6195-gruner-red-purslane.aspx

[10] 475 72's cell trays = 32,520 plants (plus 5% extra plants); $12x 475 = $5,700.00.

[11] Estimated for soluble fertilizer – exact amounts will depend on nitrate and soil tests

[12] In 2011 5,380 boxes X $1.20box = $ 6,456.00. In 2012 6,544 boxes X 1.20 box = $ 7,852.80

[13] In 2011 5,380 bags and 6,544 bags in 2012 ($ 0.024 per bag): http://www.interplas.com/gusseted-poly-bags/3-mil-gusset-on-roll-plastic-bags

[14] 1000 rubber band: $ 5.00,

[15] In 2011 5,380 labels and 6,544 labels in 2012 ($ 0.10 per label).

[16] 1000 boxes per hour of transportation ($20 per hour) and hour of labor ($14 per hour). 2011 equal to 5.38 hours X 20 + 5.38 X 14= $ 182.92. In 2012 6.54 hours X 20 + 6.54 X 14= $ 222.36

[17] PVGA commission (17%) from total gross income

[18] 1000 per week, keeping during 10 weeks (10,000 recipes, price 0.05)

[19] Cost per week $60 (10 weeks)

[20] 2011: 17,110 Kg X $ 6.31 = $ 107,964.10; 2012: 20,813 Kg X 6.31 = $131,330.03 ($16.31 wholesale price).

[21] 2011: 17,110 Kg X $ 19.65 = $ 336,211.50; 2012: 20,813 Kg X 19.65 = $408,975.45 ($19.65 retail price).

APPENDIX E

ENTERPRISE BUDGET WITH VARIABLE COSTS FOR HIERBA MORA TYPE A 2011 AND 2012

Enterprise budget for hierba mora[1] -*Solanum Spp*	Hierba Mora A 2011		Hierba Mora A 2012	
Activities	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)
Take soil tests	3.00	-	3.00	-
Plow and disk	9.88	9.88	9.88	9.88
Apply compost[2]	24.70	24.70	24.70	24.70
Lay plastic and drip	12.35	9.88	12.35	9.88
Transplant Hierba Mora[3]	58.23	19.76	58.23	19.76
Set up drip system	14.82	14.82	14.82	14.82
Cultivate weeds[4]	59.28	49.40	59.28	49.40
Water and fertigate	98.80	-	98.80	-
Scout for pests	15.00	-	15.00	-
Harvest and pack[5]	998.25	-	778.00	-
Internal product transportation (labor and machinery)[6]	3.50	3.50	3.10	3.10
Prepare soil and plant cover crop[7]	49.00	49.00	49.00	49.00
Total hours	1,346.81	180.94	1,126.16	180.54
Total labor costs	$18,855.34	$3,618.80	$15,766.24	$3,610.80
Materials (based on 1 hectare)				
Soil tests (2 basic and 4 nitrate tests)	$70.00		$70.00	
Compost	$1,976.00		$1,976.00	
Black plastic mulch and drip[8]	$645.50		$645.50	
Seed[9]	$1,920.00		$1,920.00	
Transplants[10]	$5,700.00		$5,700.00	
Fertilizer through drip[11]	$494.00		$494.00	
	$10,805.50		$10,805.50	
Packaging cost				
Boxes[12]	$4,791.60		$3,734.40	
Plastic bags[13]	$95.83		$74.69	
Rubber band[14]	$19.97		$15.56	
Labels[15]	$399.30		$311.20	
	$5,306.70		$4,135.85	
Marketing cost				
Delivery to PVGA[16]	$119.00		$105.40	
Marketing delivery[17]	$10,694.70		$9,522.72	
	$10,813.70		$9,628.12	
Promotion cost				
Recipes[18]	$500.00		$500.00	
Commercials or radio[19]	$600.00		$600.00	
	$1,100.00		$1,100.00	
Total costs and returns (based on 1 Hectare)				
Labor costs	$18,855.34		$15,766.24	
Machinery costs	$3,618.80		$3,610.80	
Material costs	$10,805.50		$10,805.50	
Packaging costs	$5,306.70		$4,135.85	
Marketing costs	$10,813.70		$9,628.12	
Promotion costs	$1,100.00		$1,100.00	
Total costs	$50,500.04		$45,046.51	
Total returns[20]	$ 83,806.80		$ 72,593.40	
Net (Total returns – Total costs)[21]	$33,306.76		$27,546.89	

[1]Labor costs based on 1 Hectare, 30,520 plants per hectare. For this calculation were used 3 cuttings in both years.

[2] Based on soil test results – no lime needed. Applied 4.94 tons/ Hectare of compost @ $400/ton

[3]Included: popping plants from trays is equal to 5 hours putting plants into holes from the planting machine done by three people (total 15 hours) and planting plants on the ground is equal to 43.23 hours. Total time: **58.23 hours.**

[4] Combination of tractor, rototiller and by hand

[5] Hierba mora A (2011): based on 14,119 Kg /hectare (10% waste equal to 1,412 Kg); 12,698 Kg/ 3.18 Kg per box =3,993 boxes; 4 boxes/person/hour = **998.25** hours of labor. Hierba Mora A (2012): based on 10,999 Kg/ hectare (10% waste equal to 1,100 Kg), 9,899 Kg/ 3.18 Hg per box = 3,112 boxes; 4 boxes/person/hour = 778 hours.

[6] Internal transportation to move produce from field to packing facility, 1000 boxes per hour, equal to 3.5 hours in 2011 and 3.1 hours in 2012.

[7] Includes removing plastic

[8] $370.5 for drip; $75 for header; $200 for 1 mil black embossed = $645.50

[9] Mora A: based on 30,520 plants/ hectare (black plastic 1.83 meters on center with 2 rows and 30 centimeters within rows) which is 960 packages of seeds (an estimated of 90% of germination rate). = $2 x 960 packages = $ 1,920.00 (based on 35 seeds/package, source from Rare Seeds): http://www.rareseeds.com/garden-huckleberry/?F_Keyword=berries

[10] 475 72's cell trays = 32,520 plants (plus 5% extra plants); $12x 475 = $5,700.00.

[11] Estimated for soluble fertilizer – exact amounts will depend on nitrate and soil tests

[12] Hierba Mora (2011): 3,993 boxes X $1.20box = $ 4,791.60. Hierba mora (2012): 3,112 boxes X 1.20 box = $ 3,734.40.

[13] In 2011 3,993 bags and 3,112 bags in 2012 similar to ($ 0.024 per bag): http://www.interplas.com/gusseted-poly-bags/3-mil-gusset-on-roll-plastic-bags

[14] 1000 rubber band: $ 5.00.

[15] In 2011 3,993 labels and 3,112 labels in 2012 ($ 0.10 per label).

[16] 1000 boxes per hour of transportation ($20 per hour) and hour of labor ($14 per hour). 2011 equal to 3.5 hours X 20 + 3.5 X 14= $ 119.00. In 2012 3.10 hours X 20 + 3.10 X 14= $ 105.40.

[17] PVGA commission (17%) from total gross income

[18] 1000 per week, keeping during 10 weeks (10,000 recipes, price 0.05)

[19] Cost per week $60 (10 weeks).

[20] Yield hierba mora A (2011): 12,698 Kg X $6.60 =$ 83,806.80. Yield hierba mora A (2012): 10,999 Kg X $ 6.60 = $ 72,593.40

[21] 12,698 Kg X $ 19.65 = $249,515.70; 2012: 10,999 Kg X $ 19.65 = $ 216,130.35 (retail price $ 19.65 per Kg).

APPENDIX F

ENTERPRISE BUDGET WITH VARIABLE COSTS FOR HIERBA MORA TYPE B 2011

Enterprise budget with Variable Costs Hierba Mora[1] -*Solanum Spp*	Hierba Mora B 2011	
Activities	Labor hrs ($14.00/hr)	Machinery hrs ($20.00/hr)
Take soil tests	3.00	-
Plow and disk	9.88	9.88
Apply compost[2]	24.70	24.70
Lay plastic and drip	12.35	9.88
Transplant Hierba Mora[3]	58.23	19.76
Set up drip system	14.82	14.82
Cultivate weeds[4]	59.28	49.40
Water and fertigate	98.80	-
Scout for pests	15.00	-
Harvest and pack[5]	2,589.00	-
Internal product transportation (labor and machinery)[6]	10.40	10.40
Prepare soil and plant cover crop[7]	49.00	49.00
Total hours	2,944.46	187.84
Total labor costs	$41,222.44	$3,756.80
Materials (based on 1 hectare)		
Soil tests (2 basic and 4 nitrate tests)	$70.00	
Compost	$1,976.00	
Black plastic mulch and drip[8]	$645.50	
Seed[9]	$1,920.00	
Transplants[10]	$5,700.00	
Fertilizer through drip[11]	$494.00	
	$10,805.50	
Packaging cost		
Boxes[12]	$12,426.00	
Plastic bags[13]	$248.52	
Rubber band[14]	$51.77	
Labels[15]	$1,035.55	
	$13,761.84	
Marketing cost		
Delivery to PVGA[16]	$353.60	
Marketing delivery[17]	$31,686.30	
	$32,039.90	
Promotion cost		
Recipes[18]	$500.00	
Commercials or radio[19]	$600.00	
	$1,100.00	
Total costs and returns (based on 1 Hectare)		
Labor costs	$41,222.44	
Machinery costs	$3,756.80	
Material costs	$10,805.50	
Packaging costs	$13,761.84	
Marketing costs	$32,039.90	
Promotion costs	$1,100.00	
Total costs	$102,686.48	
Total returns[20]	$217,331.40	
Net for farmer (Total returns – Total costs)	$114,644.92	
Total returns for supermarket[21]	$434,662.8	

[1] Labor costs based on 1 Hectare, 30,520 plants per hectare. For this calculation were used 3 cuttings in both years.

[2] Based on soil test results – no lime needed. Applied 4.94 tons/ Hectare of compost @ $400/ton

[3] Included: popping plants from trays is equal to 5 hours putting plants into holes from the planting machine done by three people (total 15 hours) and planting plants on the ground is equal to 43.23 hours. Total time: **58.23 hours.**

[4] Combination of tractor, rototiller and by hand

[5] Hierba mora B (2011): based on 36,588 Kg/ hectare (10% waste equal to 3,659) 32,929 Kg/3.18 Kg 10,355 boxes; 4 boxes/person/hour = **2,589 hours.**

[6] Internal transportation to move produce from field to packing facility, 1000 boxes per hour, equal to 10.4 hours.

[7] Includes removing plastic

[8] $370.5 for drip; $75 for header; $200 for 1 mil black embossed = $645.50

[9] Mora B: based on 30,520 plants/ hectare (black plastic 1.83 meters on center with 2 rows and 30 centimeters within rows) which is 960 packages of seeds (an estimated of 90% of germination rate). = $2 x 960 packages = $ 1,920.00 (based on 35 seeds/package, source from Rare Seeds): http://www.rareseeds.com/garden-huckleberry/?F_Keyword=berries

[10] 475 72's cell trays = 32,520 plants (plus 5% extra plants); $12x 475 = $5,700.00.

[11] Estimated for soluble fertilizer – exact amounts will depend on nitrate and soil tests

[12] Hierba Mora (2011): 10,355 boxes X $1.20box = $ 12,426.00

[13] In 2011 10,355 bags ($ 0.024 per bag): http://www.interplas.com/gusseted-poly-bags/3-mil-gusset-on-roll-plastic-bags

[14] 1000 rubber band: $ 5.00.

[15] In 2011 10,355 labels ($ 0.10 per label).

[16]1000 boxes per hour of transportation ($20 per hour) and an hour of labor ($14 per hour), equal to 10.4 hours X 20 + 10.4 X 14= $ 353.60.

[17] PVGA commission (17%) from total gross income

[18] 1000 per week, keeping during 10 weeks (10,000 recipes, price 0.05)

[19] Cost per week $60 (10 weeks).

[20] 2011: 32,929 Kg X $6.60= 217,331.40 (Wholesale price $ 6.60 per Kg)

[21] 2011: 32,929 Kg X $13.20= 434,662.8 (Retail price $ 13.20 per Kg)

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